INVITATION TO BID
FOR
FC-6260, PEACHTREE CREEK SOUTH FORK RELIEF STORAGE AND PUMPING STATIONS
(VOLUME 2)

Atlanta, Georgia

Kasim Reed
Mayor
City of Atlanta

JoAnn J. Macrina, P.E.
Commissioner
Department of Watershed Management

Adam L. Smith, Esq., CPPO, CPPB
Chief Procurement Officer
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FC-6260, Peachtree Creek and South Fork Relief Storage and Pumping Stations

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SECTION 01005
MISCELLANEOUS REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL

A. Conform to all miscellaneous requirements as herein specified.

1.02 INTERFERENCE WITH EXISTING WORKS

A. The Contractor shall at all times conduct its operations so as to minimize or completely eliminate interference with existing works. The Contractor shall develop a program, in cooperation with the Engineer and site personnel, which shall provide for the construction and putting into service of the new works in the most orderly manner possible. This program shall be adhered to except as deviations therefrom are expressly permitted. All work of connecting with, cutting into, and reconstructing existing pipes or structures shall be planned to minimize or completely eliminate interference with the operation of the existing facilities. It may be necessary to work outside of normal working hours to meet these requirements. Before starting work which is likely to interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all tools, materials, and equipment are made ready and at hand.

B. The Contractor shall make such minor modifications in the work relating to existing structures as may be necessary, without additional compensation.

C. The Contractor shall have no claim for additional compensation by reason of delay or inconvenience in adapting his operations to meet the above requirements.

1.03 MAINTAINING SEWAGE WATER, AND STORM WATER FLOWS AND OTHER UTILITIES AND PROCESS FLOWS

A. It is essential to the operation of existing facilities that there be no interruption. To this end, the Contractor shall provide, maintain, and operate all temporary facilities such as dams, pumping equipment, conduits, and all other labor and equipment necessary to intercept these utilities before they interfere with the work, carry them past the work, and return them to the existing utilities below the work.

B. Minimum facility usage flow occurs during the night hours and weekends. The Contractor may work on the existing utilities at such times if he so chooses at no additional cost to the City.

1.04 SPECIAL MATERIALS HANDLING

A. Groundwater and excavated material are indicated to have possible contamination that requires special handling. The Contractor is responsible to properly dispose of any contaminated materials as required by applicable Federal, State, and local laws, regulations, standards and requirements. Refer to specification section 01010-Summary of Work for further information.

1.05 PHASE CONSTRUCTION

A. Work under this contract is to be accomplished in a timely manner and in accordance with the completion time set forth in the Agreement Documents for this project.

1.06 MOTOR AND STARTING EQUIPMENT DATA LIST

A. Each Contractor shall obtain the necessary data from its equipment suppliers, and shall prepare a complete tabulation of all motors over 1/3 hp, and all electric heaters, to be furnished under his contract.

B. The motor and heater tabulation shall include firm and accurate information as follows:

1. Name and identification of equipment.
2. Manufacturer.
3. Horsepower or kilowatt rating.
4. Voltage.
5. Phase.
6. Speed.
7. Full load current.
8. Locked rotor current or code letter.
9. Type of enclosure (open dripproof, totally enclosed, fan cooled, etc.)
10. Automatic control equipment used (if applicable).
11. NEMA size of starter or contactor.
12. Overload heater size.
13. Type of starter (full-voltage, reduced-voltage, autotransformer, etc.).
14. Breaker trip setting or fuse size.
15. Voltage of starter operating coil.
16. If starter is at a motor control center, list motor control center number.

C. The correct submission of starting equipment shop drawings is dependent upon timely submission of the complete motor and electric heater tabulation. To this end, all Contractors shall cooperate fully in the assimilation and dissemination of motor and electric heater data.

D. Three copies of the tabulation shall be furnished to the Engineer. Two copies shall also be furnished concurrently to the Electrical Contractor, to use in preparing his order for starting equipment. The Electrical Contractor shall also prepare a composite tabulation of all of these motors and electric heaters, as specified under ELECTRICAL WORK - GENERAL.

1.07 VOLTAGE RATINGS OF MOTORS

A. Unless otherwise specified, motors with ratings in excess of 1/3 hp. shall be rated 460-volt (nameplate rating), three-phase, 60-Hertz; motors of 1/3 hp or less shall be rated 115-volt, single-phase, 60-Hertz.

1.08 HYDRAULIC UPLIFT OF STRUCTURES

A. The Contractor shall be responsible for the protection of all structures against hydraulic uplift until such structures have been accepted finally by the City.

B. The Contractor will coordinate its work with other contractors and activities, with specific attention to access to portions of the work. Construction sequence shall be determined by the Contractor subject to the needs for continuous access and operation by others.

END OF SECTION 01005

SECTION 01010
SUMMARY OF WORK

PART 1 - GENERAL

1.01 This section summarizes the work of the project as covered in detail in the complete Contract Documents. This is a general summary and is not intended to be complete and all inclusive of the required work items.

1.02 DESCRIPTION

A. Definition: The Work is defined per General Conditions Section GC-3.

B. Description of Work: The Work limits are shown in the Contract Documents and consist of furnishing all materials, equipment, and labor required to construct the facilities as shown on the Drawings. This Work includes properly handling all materials encountered including offsite disposal of excavation and other waste materials and proper treatment and disposal of water encountered in the excavation. This Work further includes relocation of the office trailers presently on the site to the location shown on the drawings. This work includes all activities and permitting associated with relocation, including set up at the designated location and connection to all utilities.

C. Description of Total Project: The finished project will consist of two sites named "The Equalization Site" and "The Diversion Site". The project includes the major structures and facilities that include, but are not limited to, the following items.

1. One 10-MG equalization tank.
2. One 67 MGD diversion pumping station.
3. One jet mix pumping station with 30 MGD return pumping capacity.
4. Diversion structures and associated piping.
5. Cheshire Bridge junction box.
6. Associated piping to convey diverted flows from the Diversion Site to the Equalization Site and back to the existing sanitary sewer.

1.03 CONTRACTOR'S USE OF PREMISES:

A. The contractor shall be responsible for maintaining all site access in good condition, including drainage.

B. Site Security: The Contractor shall secure area after work hours and ensure all Site gates are locked.

1.04 COORDINATION WITH OTHER ACTIVITIES:

A. The Owner may contract for other Work related to but not included in this Contract. The Contractor will coordinate his activities to facilitate other Contractor Work.

B. The Contractor shall coordinate with the Owner on the transfer of power, relocation of trailers and other activities, as necessary.

C. Owner has submitted a full set of plans and technical specifications to facilitate expedited permitting by the City of Atlanta Bureau of Buildings. Upon issuance of Notice to Proceed, the Contractor shall be responsible for completing the permits process.

1.05 SPECIAL MATERIALS HANDLING

A. Contractor is referred to the Environmental reports referenced in paragraph 1.06 regarding the potential presence of contaminated soil and / or groundwater and proper disposal of such materials.

B. Contractor shall ensure that all Federal, State, and local requirements are met for the removal, testing, transport, and disposal of any contaminated materials.

1.06 LIST OF REFERENCES:

A. Reference Materials:

1. The following reference materials are provided as attachments to these specifications for the Contractors information only:

   a. Geotechnical report dated October 9, 2012 and Addendum 1 dated October 30, 2012 prepared by Willmer Engineering, Inc. and titled:

      REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION
      Liddell Drive Equalization Project
      Atlanta, Fulton County, Georgia

   b. Environmental assessment report dated August 31, 2012 by United Consulting and titled:

      Phase II
      Environmental Assessment
      Liddell Drive Equalization Project
      Atlanta, Georgia

   c. Survey for asbestos and lead dated August 2, 2012 by United Consulting and titled:

      Asbestos and Lead Based Paint Survey
      Liddell Drive
      Fulton County
      Atlanta, Georgia

B. All reports and studies are for information only. It is the Contractor's responsibility to satisfy itself as to the accuracy and completeness of the information provided. Additional studies and investigations may be performed by the Contractor at no additional cost to the City.

END OF SECTION 01010

SECTION 01011
UNIQUE REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

A. The scope of this Section is to convey to the Contractor unique and unusual stipulations and requirements, which have been established for this Project. Some of the stipulations and requirements are a result of negotiations with various entities and organizations, which have an interest in this Project. Some requirements are based on technical aspects of the Project, which are not otherwise conveyed to the Contractor. The provisions of this Section shall supersede the provisions of the Division 1 through 16 Specifications, but shall not supersede the Bidding Requirements, Contract Forms or Conditions of the Contract.

1.02 SEQUENCING

A. General: The Contractor shall be solely responsible for all construction sequencing.

B. The Contractor shall notify the City at least 48 hours prior to any land disturbing activities, relocating piping, or diverting flows.

C. Sequence Submittal

1. Submit a proposed sequence of tasks with appropriate times of starting and completion of each task to the Engineer for review within ten (10) days of the Notice to Proceed.

2. The Contractor may propose alternatives to the sequencing constraints shown in this Section in an attempt to reduce the disruption of the operation of the existing facility or streamline the tasks of this Contract. The City and the Engineer are not obligated to accept any of these alternatives.

1.03 DIVERSION FACILITY SITE SPECIAL REQUIREMENTS

A. Work at the project site may be performed 24 hours per day, seven days per week. Blasting hours shall be as noted in Section 02405. The Contractor must comply with local requirements including those controlling noise, light, and construction traffic. Costs incurred by the Owner for additional inspection and engineering for work beyond 8 hours work day 5 days work week will be reimbursed by the Contractor.

B. Blasting may not be performed prior to completion of pre-blast surveys or approval of blast plans.

C. Trucks are not permitted to access the Diversion Facility site via the CSX crossing west of the site and adjacent to 2039 Cheshire Bridge Road.

D. Parking for Contractor personnel shall be fully contained within the site boundaries. No parking is permitted on any public roads. If necessary, the Contractor shall make arrangements for remote parking for its personnel, at a site approved by the Engineer, at no additional cost to the City.

E. The Contractor is responsible for protecting the existing utility lines and radio tower above and below-ground facilities and shall be responsible for the repair and damages resulting from his

construction activities to these systems. In addition to the requirements of Special Conditions Section SC-8 the Contractor shall verify the actual locations of various buried lines shown on the Drawings by carefully excavated test pits or other direct means before starting Work in any given area at no additional cost to the City. Special care shall be taken during any excavation to mitigate potential damage in case previously unknown and active systems are encountered.

F. Groundwater discharged from the equalization facility site will be discharged to a storm sewer or waterway in accordance with the requirements of Section 02140 – Dewatering.

G. Unless shown otherwise on the Drawings or directed by the Engineer, the Contractor shall restore the site to its original grade. Any fill placed at the site to return it to its original grade shall be controlled fill, approved by the Engineer. The site shall be grassed and mulched. Final landscaping, including grassing, trees and shrubs shall be paid under Bid Item No. 1. Contractor shall stockpile native top soil for re-use during landscaping.

1.04 EQUALIZATION FACILITY SITE SPECIAL REQUIREMENTS

A. Work at the Equalization Facility site may be performed 24 hours per day, seven days per week. Blasting hours shall be as noted in Section 02405 Blasting. The Contractor must comply with local requirements including those controlling noise, light, and construction traffic. Costs incurred by the Owner for additional inspection and engineering for work beyond 8 hour work day 5 day work week will be reimbursed by the Contractor.

B. Blasting may not be performed prior to completion of pre-blast surveys or approval of blast plans.

C. The removal of the existing radio tower from the equalization facility site is underway by Others. The Contractor is responsible for protecting the existing utility lines and radio tower above and below-ground facilities and shall be responsible for the repair and damages resulting from his construction activities to these systems until the tower is removed. In addition to the requirements of Special Conditions Section SC-8 the Contractor shall verify the actual locations of various buried lines by carefully excavated test pits or other direct means at no additional cost to the City. Special care shall be taken to mitigate potential damage in case previously unknown and active systems are encountered.

D. Groundwater discharged from the equalization facility site will be discharged to the sanitary sewer system in accordance with the requirements of Section 02140 – Dewatering.

E. Parking for Contractor personnel shall be fully contained within the site boundaries. No parking is permitted on any public roads, or on Miss Astor Place. If necessary, the Contractor shall make arrangements for remote parking for its personnel, at a site approved by the Engineer, at no additional cost to the City.

F. The Contractor is responsible for protecting the existing utility lines and shall be responsible for the repair and damages resulting from his construction activities to these systems. In addition to the requirements of the Special Conditions Section SC-8 the Contractor is required to verify the actual locations of various buried lines shown on the Drawings by carefully excavated test pits and other direct means before starting Work in any given areas at no additional cost to the City. Special care shall be taken during any excavation to mitigate potential damage and minimize damage in case previously unknown and active systems are encountered.

G. Except where shown otherwise on the Drawings or directed by the Engineer, the Contractor shall restore any disturbed areas on the site to its original grade. Any fill placed at the site to return it to its original grade shall be controlled fill, approved by the Engineer. All disturbed areas shall be stabilized. Any temporary erosion control stabilization required during the course of the Work shall be at the contractor's expense and no additional compensation will be paid. Any final landscaping, including trees and shrubs, but not including grassing, shall be paid under the Site Landscaping Allowance Item. Contractor shall stockpile native top soil for re-use during landscaping.

H. Existing structures to be demolished may contain hazardous materials such as lead and asbestos. These contaminants shall be removed by under this Contract Agreement in accordance with federal, state and local laws, rules and regulations and shall be paid as part of the Contractor's lump sum bid item. The Contractor is responsible for inspecting and satisfying himself that material removal is complete and that no hazardous materials will be encountered prior to other demolition activities.

1.05 POWER SUPPLY

A. The contractor is responsible for all power needs and costs for the Work except as described in specification Section 01200 - Measurement and Payment. No additional compensation will be paid for Power Service.

B. Georgia Power will ultimately supply the power needs for the Project. They have been advised on the approximate power requirements for the completed Project and the probable locations for the substations. If the Contractor requires power service for the Work he shall contact Georgia Power for specific technical, schedule, and cost information required for the Project. No additional compensation for power supply will be made. The contact person is as follows:

Ms. Kristie Drury
Key Account Manager
Georgia Power Metro Key Accounts
5215 Minola Drive
Lithonia, Georgia 30038-2310
Office Phone: (770) 322-5733
Cell Phone: (404) 513-5984
Office Fax: (770) 322-5780

END OF SECTION 01011

SECTION 01014
WORK SEQUENCE

PART 1 - GENERAL

1.01 SCOPE

A. Work under this Section includes construction sequencing and provision of temporary facilities necessary to maintain the operation of the existing sewer and to prevent wastewater overflows/spills and basement flooding during the performance of this Work.

1. It is intended to provide guidance to the Contractor for preparing the detailed construction schedule specified in SC-16.
2. The contractor is free to change the order in which various facilities are constructed as he sees fit, subject to the approval of the engineer, as long as the changes meet the stated project goals.
3. The sequence specified herein does not address the means and methods of performing the construction as these are the contractor's sole responsibility.

B. Use of the specified sequence of construction is not guaranteed by the engineer to meet the specified project goals. The scheduling and performance of construction operations is solely the Contractor's responsibility. The construction sequence specified is solely to advise the Contractor of some of the more important considerations necessary to develop the detailed construction schedule.

C. The existing sewer is currently and continuously conveying sewage, and that function shall not be interrupted except as specified herein. The Contractor shall comply with the following general requirements:

1. Provide temporary pumps, piping, and other facilities necessary to meet the requirements of this Section.
2. Notify the Engineer at least forty-eight (48) hours prior to connection to the existing pipe or taking existing system components out of service.
3. Bypassing of untreated sewage to surface waters or drainage courses is prohibited during construction. In the event accidental overflows or spills are caused by the Contractor's operations, the Owner shall immediately be entitled to employ others to stop the bypassing without giving written notice to the Contractor.

D. Penalties imposed on the Owner as a result of any overflows or spills caused by the actions of the Contractor, his employees, or subcontractors, shall be borne in full by the Contractor, including legal fees and other expenses to the Owner resulting directly or indirectly from the event.

E. Contractor shall insure that all permits required for Work are obtained in a timely manner prior to commencement of Work to insure timely completion of Work in accordance with approved schedule. Contractor acknowledges that permits for such as items as tree removal or disturbance (Tree Plans), road closures, and other required permits may require additional documentation. Contractor should allow adequate time to obtain such permits.

1.02 SUBMITTALS

A. In accordance with the General Conditions, the Contractor shall submit a detailed outage plan and time schedule for operations which will make it necessary to remove a pipeline or structure from service. The schedule shall be coordinated with the construction schedule specified in the Special Conditions and shall meet the restrictions and conditions specified in this section. The detailed plan shall describe:

1. The Contractor's method for maintaining service while preventing overflows, surcharging, or spills.
2. The length of time required to complete said operation.
3. Equipment or temporary bypassing and shut down requirements from the beginning to the end of construction activities.
4. Contingency plan to deal with problems which could occur during the construction period. Examples include high flows, pump failure, etc.

B. Sequence Submittal: The sequence provided in Part 3 of this Section is offered as a suggestion to the Contractor. Submit a proposed sequence with appropriate times of starting and completion of tasks to Engineer for review.

C. Alternate Sequences: Contractor may propose alternate sequences to that shown in Part 3 of this Section in an attempt to reduce the disruption of the operation of the existing facility or streamline the tasks of this Contract.

1.03 SYSTEM INTERRUPTION

A. At least two weeks prior to any proposed activity which will require any portion of the system be removed from operation, require temporary bypassing or require interruption of flow, the Contractor shall schedule a meeting with Owner's Operating Personnel and the Engineer. At this meeting, the Contractor shall present Contractor's detailed plan for the proposed operation for general discussion. The plan shall meet the minimum requirements below:

1. Plan shall be written outline form and presented in a format which shall show the progression of events in sequential and/or concurrent order of activity and the duration of each activity.
2. The written plan shall be supplemented by drawings, sketches, and details as required to show the logic of the plan and make it understandable.
3. The plan shall delineate the responsibilities of the Owner's Operating Personnel and the Contractor, so as to eliminate any delay due to conflicting viewpoints upon implementation of the plan.
4. After discussion of the plan at the meeting, any changes agreed upon shall be incorporated into the plan and a copy of the plan and details shall be distributed to Owner's Operating Personnel, the Engineer, and Contractor personnel at least one week prior to commencement of activities. On the day prior to commencement of activity a brief meeting of involved parties shall be convened. In this meeting the starting time and initial activity of Owner's Operating Personnel and Contractor's personnel shall be agreed upon.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. The sequence of construction is outlined for the major items of Work required; no attempt has been made to describe every detail of the Project. The Contractor shall coordinate his work with the Owner's Operating Personnel to minimize disruptions in sewer system operation. It shall be the Contractor's responsibility to ensure that all existing facilities are protected and will not be damaged as a result of this construction. No settlement of existing facilities will be acceptable and all work shall be performed in a safe manner.

B. Equalization Site:

1. Earthwork
2. 10 MGD Prestressed Concrete Tank and piping
3. Jet-Mix Pump Station (concurrent with tank) and piping
4. Cheshire Bridge Junction Box

C. Diversion Site:

1. Earthwork, retaining wall, and force main piping
2. Diversion Pump Station and piping
3. Diversion Structures and gravity piping

3.02 MISCELLANEOUS CONSTRUCTION

A. Miscellaneous work necessary to complete any flow diversion required may include piping, pumps, electrical work, diversion plugs, bulkheads, and equipment installation, etc. The cost for these items shall be included in the Contractor's base bid.

END OF SECTION 01014

SECTION 01040
COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall coordinate execution of the Work with subcontractors and the Engineer as required to maintain operation of the existing facilities and satisfactory progress of the Work.

B. Requirements of this Section will be in addition to those stated in the General Conditions.

C. The Engineer may require a written explanation of the Contractor's plan for executing separate phases of the Work.

1.02 CUTTING AND PATCHING

A. The Contractor shall leave all chases or openings for the installation of its own or any of its subcontractor's Work, or shall cut the same in existing work, and shall see that all sleeves or forms are at the work and properly set in ample time to prevent delays. The Contractor shall ensure that all such chases, openings, and sleeves are located accurately and are of proper size and shape, and shall consult with the Engineer and its subcontractors concerned in reference to this Work. In case of its failure to leave or cut all such openings or have all such sleeves provided and set in proper time, the Contractor shall cut them or set them afterwards at its own expense, but in so doing shall confine the cutting to the smallest extent possible consistent with the work to be done. In no case shall structural members be cut without the written approval of the Engineer.

B. The Contractor shall carefully fit around, close up, repair, patch, and point around the Work specified herein to the satisfaction of the Engineer.

C. All of this work shall be done by careful workers competent to do such work and with the proper small hand tools. Power tools shall not be used except where, in the opinion of the Engineer, the type of tool proposed can be used without damage to any work or structures and without inconvenience or interference with the operation of any facilities. The Engineer's approval of the type of tools shall not in any way relieve or diminish the responsibility of the Contractor for such damage, inconvenience, or interference resulting from the use of such tools.

D. Do not cut or alter the work of any subcontractor, except with the written consent of the contractor whose work is to be cut or altered, or with the written approval of the Engineer. All cutting and patching or repairing made necessary by the negligence, carelessness or incompetence of the Contractor or any of its subcontractors, shall be done by, or at the expense of, the Contractor and shall be the responsibility of the Contractor.

1.03 EXISTING UTILITIES

A. The Contractor shall consult with the Engineer on a daily basis while performing demolition, excavation, or any other alteration activity. No sewer function, utility, or structure shall be altered, shut off, or removed unless approved in advance, and in writing, by the Engineer. The Contractor shall give the Engineer at least 48 hours advanced notice, in writing, of the need to alter, shut off or remove such function.

B. Coordinate the Work with the Engineer and revise daily activities if needed so as to not to adversely affect system operations. Such revisions in the proposed work schedule will be accomplished with no additional compensation to the Contractor.

C. Comply with the requirements of Section 01011 of these Specifications.

END OF SECTION 01040

SECTION 01060
REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE

A. Permits and Responsibilities. The Contractor shall, without additional expense to the City, be responsible for obtaining NPDES permits for stormwater discharges from this Project, and for complying with any applicable federal, state, and local laws, regulations, standards, policies and requirements in connection with the prosecution of the Work.

B. The Contractor shall, without additional expense to the City, be responsible for obtaining permits for contaminated material disposal, including dewatering discharges, from this Project, and for complying with any applicable federal, state, and local laws, regulations, standards, policies and requirements, in connection with the prosecution of the Work.

C. The Contractor shall take proper safety and health precautions to protect the Work, the workers, the public, and the property of others.

D. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance of the Work, except for any completed unit of construction thereof which may heretofore have been accepted.

1.02 NPDES PERMITS FOR STORM WATER DISCHARGES

A. The Federal Water Pollution Control Act (also known as the Clean Water Act (CWA)), as amended in 1987, requires National Pollutant Discharge Elimination System (NPDES) permits for storm water discharges associated with industrial activity.

B. On November 16, 1990, (55 FR 47990), the Environmental Protection Agency (EPA) issued regulations establishing permit application requirements for storm water discharges associated with industrial activity. These regulations are primarily contained in Section 122.26 of Section 40 of the Code of Federal Regulations (40 CFR Part 122.26).

C. The November 16, 1990 regulation established the following definition of "storm water discharge associated with industrial activity" at 40 CFR 122.26(b)(14):

"Storm water discharge associated with industrial activity" means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. For the categories of industries identified in subparagraphs (i) through (x) of this subsection, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are

exposed to storm water. The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:

(i) through (ix) omitted for brevity.

(x) Construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale;

D. These regulations are effective for all activities covered by the regulation on or after October 1, 1992.

E. As a minimum, the Contractor shall complete EPA Form 3510-2F. A manual entitled "Guidance Manual for the Preparation of NPDES Permit Applications for Storm Water Discharges Associated with Industrial Activity" as published by the United States Environmental Protection Agency, is available to assist the Contractor in the application process.

END OF SECTION 01060

SECTION 01200
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 SCOPE

A. Work includes furnishing all plant, labor, equipment, tools, materials, and performing all operations required to complete the Work satisfactorily, in-place, as specified and as indicated on the Drawings.

B. All costs of required items of work and incidentals necessary for the satisfactory completion of the Work shall be considered as included in the Bid Total. The cost of work not directly covered by the pay items shall be considered incidental to the Contract and no additional compensation shall be allowed.

C. The Contractor shall take no advantage of any apparent error or omission on the Drawings or Specifications, and the Engineer shall be permitted to make corrections and interpretations as may be deemed necessary for fulfillment of the intent of the Contract Documents.

1.02 SUBMITTALS

A. The Contractor shall submit to the Engineer for approval, in the form directed or acceptable to the Engineer, a complete schedule of values of the various portions of the Work, including quantities and unit prices, aggregating the Contract Price. An unbalanced breakdown providing for overpayment to the Contractor on items of Work, which would be performed first, will not be approved.

B. Submit application for payment on a form approved by the Engineer showing allowances, lump sum schedule of value items, and unit price items in accordance with Section SC-16.

C. Final payment quantities shall be determined from the record drawings. The record drawing lengths, dimensions, quantities, etc. shall be determined by a survey after completion of all required work. The precision of final payment quantities shall match the precision shown for that item in the Bid Schedule.

1.03 LUMP SUM ITEM

A. Payment of the lump sum item (Bid Item No.1) established in the Contractor's Bid shall be full compensation for all labor, materials, and equipment required to furnish, install, construct, and test the Work covered under the lump sum bid item.

B. Payment of the lump sum item (Bid Item No.1) established in the Contractor's Bid shall also fully compensate the Contractor for any other work which is not specified or shown, but which is necessary to complete the Work.

C. The lump sum item shall be specifically subdivided by Activity, broken-out in the Schedule of Values.

D. Payments for the lump sum items specifically broken-out in the Schedule of Values will be based upon physical progress for each activity in accordance with the breakdown of the Lump Sum prices agreed to in the Schedule of Values.

1.04 UNIT PRICE ITEMS

A. Payment for all work shall be in accordance with the unit price bid items in the Bid Schedule and shall be full compensation for all labor, materials, and equipment required to furnish, install, construct, and test the Work covered under the unit price bid item. Work for which there is no price schedule item will be considered incidental to the Work and no additional compensation shall be allowed.

B. Payment will be made only for the actual quantities of work performed in compliance with the Drawings and Specifications. The Contractor will be paid an amount equal to the approved quantity multiplied by the applicable unit price. Any unused balance of the unit price work shall revert to the City upon completion of the Project.

C. All unit price work shall be considered as part of the Work to be performed within the time limits specified elsewhere for Substantial Completion and Project Completion. No increase in Contract time will be allowed for increases in quantities of unit price work performed beyond the quantities shown in the Bid Schedule, unless it can be demonstrated that the additional Work performed under the unit price item is on the critical path of the Project Schedule.

D. All variable costs associated with variation in quantities shall be included in the unit prices. All fixed costs associated with performing the items of work for which unit prices are paid shall be included in Item 1 of the Bid.

1.05 ITEM NO.1- ALL WORK TO COMPLETE

A. All work to complete the Project, and which is not included in all other Items, shall be included in the lump sum amount bid for Item No.1 of the Bid. Item No. 1 shall include, but not be limited to, the following specific items:

1. Mobilization and demobilization.
2. Bonds and Insurance.
3. Document control including requirements of section 01350.
4. Permits including but not limited to land disturbance permit, demolition permit, building permit.
5. Temporary facilities as described in section 01500.
6. Excavation and backfill, including all excavation support systems, e.g., sheeting, bracing,, and timbering.
7. Design, installation, maintenance and operation of dewatering systems.
8. Site security.
9. Site landscaping.
10. Erosion, sediment, and water pollution prevention and control measures.
11. Removal of all temporary facilities, site improvements and restoration.

12. Traffic control (both on and off site).
13. Temporary access road construction and maintenance.
14. Testing and commissioning of all facilities.
15. Operation and maintenance of all facilities during the acceptance testing period.

1.06 ITEM NO. 2 – HAUL AND DISPOSE TO SUBTITLE D LANDFILL

A. Haul and dispose of non-hazardous excavated waste material offsite. This material is required to be land filled but is not hazardous and may be disposed of in a Subtitle D landfill.

B. Measurement for payment shall be made based upon actual Landfill Dump Tickets showing the actual weight of material, truck identification, date, and time. The contractor shall maintain a log of all trucks entering and leaving the site. No payment will be made for landfill dump tickets that are not cross-referenced to the contractor's truck record log.

1.07 ITEM NO. 3 – HAUL AND DISPOSE TO SUBTITLE C LANDFILL

A. Haul and dispose of hazardous excavated waste material offsite. This material is required to be land filled, is considered hazardous, and must be disposed of in a Subtitle C landfill.

B. Measurement for payment shall be made based upon actual Landfill Dump Tickets showing the actual weight of material, truck identification, date, and time. The contractor shall maintain a log of all trucks entering and leaving the site. No payment will be made for landfill dump tickets that are not cross-referenced to the contractor's truck record log.

1.08 ITEM NO. 4 – ALLOWANCES

A. The allowances specified in the Bid Schedule are to establish a fund to pay the cost of items for which the City could not establish accurate quantities and/or detailed scope of work. This work shall be completed only at the written direction of the Engineer, and the cost of such work shall be approved prior to performance of the work.

B. The Contractor shall be responsible for the payment for these services to the appropriate payee providing such service, and shall submit evidence of payments to the Engineer prior to its inclusion in the progress payments.

C. Payment will be made for invoices submitted by the Contractor subject to the conditions and limitations in the Contract Documents.

D. Allowance allocations shall only be paid to the Contractor for completed work authorized by the Engineer. All allowance dollar amounts not expended shall revert to the City at the completion of the Project. Should the allowance costs be greater than the specified amount of the allowance, the Contract will be adjusted accordingly by change order. The amount of change order will not recognize any changes in handling costs at the site, labor, overhead, profit and other expenses caused by the adjustment to the allowance item.

E. Item 4a - Partnering: An allowance has been established as the value of this item. This allowance shall be used to pay the City's 50 percent share of the direct costs of an outside facilitator and conference facilities to conduct partnering in accordance with these Specifications. The Contractors costs for attending and participating in the partnering sessions is not covered under

this allowance item and all such costs shall be included in the Contractor's 50 percent share of the Partnering included in the Lump Sum Bid amount. The Contractor shall allocate an amount equal to this allowance in their Lump Sum Bid for paying their 50 percent share of the direct Partnering costs. Any unused portion of the amount allocated by the Contractor for their 50 percent share of the direct costs of Partnering shall be credited to the City on the Final Payment Request.

F. Item 4b - Additional Paving: An allowance has been established as the value of this item. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of additional work, where the cost amounts are determined as specified in General Condition Article GC-41.2.4 for Force Account Work. Such additional work is not to be related to repairing/repaving roadways damaged by normal wear caused by heavy construction traffic. No separate payment will be made for continuously and consistently maintaining, to their pre-construction condition, all roads and other paved surfaces used by the Contractor throughout the construction period. The cost of such work will be considered incidental to Item No. 1 of the Bid and are not part of this allowance bid item, for pavement shown on the Drawings or specified, nor for repairs of damage not related to normal wear caused by heavy construction traffic.

G. Item No. 4c - Unforeseen Utility Conflicts: An allowance has been established as the value of this item. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of additional work, where the cost amounts are determined as specified in General Condition Article GC-41.2.4 for Force Account Work. This work may be required in the event utilities not shown in the Drawings are encountered and impact the Contract related work.

H. Item No. 4d - Owner Directed Specialty Services: An allowance has been established as the value of this item. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of consultants providing specialty services to the City in support of the project including but not limited to community relations. The City selected firms, providing services to the City, shall invoice the Contractor for services rendered. The payment to the Contractor shall be based on these invoices.

I. Item No. 4e - Additional Work Elements: An allowance has been established as the value of this item. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of additional work, where the cost amounts are determined as specified in General Condition Article GC-41.2.4 for Force Account Work. This work, not shown or specified in the Drawings and Specifications bid by the Contractor and not covered by another item in the Bid Schedule, may be required in the event the Engineer establishes the need for additional work deemed to be necessary for the successful completion of this Contract.

J. Item 4f – Additional Site Landscaping: An allowance has been established as the value of this item. This allowance shall be used to pay the costs, where the amounts are determined as specified in General Condition Article GC-41.2.4 for Force Account Work for additional landscaping of the various sites of this contract as directed by the Engineer. The costs of final grading, site restoration consisting of grassing, shrub, and tree plantings, and maintenance thereof, shown in the Drawings and/or required by the specifications are not covered in this allowance item, and are to be included in Item No. 1 of the Bid.

K. Item No. 4g - Generators: An allowance has been established as the value of this item. This allowance shall be used to pay the costs, where the amounts are determined as specified in General Condition Article GC-41.2.4 for Force Account Work as directed by the engineer for backup generators. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of design, procurement, furnishing, and installing a complete. This system shall

include any necessary modifications to the existing design to accommodate the backup generator system.

L. Item No. 4h - Additional Testing: An allowance has been established as the value of this item. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of additional testing, as determined by the Owner. This allowance does not include testing required under these Agreement Documents.

M. Item No. 4i –Downstream Remote Monitoring (LE-120A and LE-120B): An allowance has been established as the value of this item. This allowance may be used to pay the costs, where the amounts are determined as specified in General Condition Article GC-41.2.4 for Force Account Work as directed by the engineer for downstream remote monitoring. This allowance may be used, as authorized and directed by the Engineer, to pay the costs of all work at remote monitoring location including electrical, instrumentation, civil and other work items associated with the downstream remote monitoring location. Location of Work is generally shown on drawing CS-105.

N. Item No 4j – Trailer Relocation: An allowance has been established as the value of this item. This allowance may be used to pay the costs, where the amounts are determined as specified in General Condition Article GC-41.2.4 for Force Account Work as directed by the engineer for relocating and setting up existing trailers at the site designated by the City, including all equipment, materials and labor to disassemble, secure, install and make trailers usable. Work shown on drawings CS-901, CG-901, CE-901, and CF-901 will be paid under this allowance.

O. The following allowances will be considered "pass through" allowances. As such, these allowances will not be subject to markup for overhead and profit:

1. Partnering.
2. Owner Directed Specialty Services.

END OF SECTION 01200

SECTION 01320
CONSTRUCTION VIDEOS AND PHOTOGRAPHS

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish all equipment, labor, and materials required to provide the Owner with digital construction videos and photographs of the Project.

B. Photo and video files shall become the property of the Owner and none of the videos or photographs shall be published without express permission of the Owner.

1.02 PRE- AND POST-CONSTRUCTION VIDEOS AND PHOTOGRAPHS

A. Prior to the beginning of any work, the Contractor shall take videos and photographs of the work area to record existing conditions.

B. Following completion of the work, another set of videos and photographs shall be made showing the same areas and features as in the pre-construction videos and photographs.

C. All conditions which might later be subject to disagreement shall be shown in sufficient detail to provide a basis for decisions.

1.03 PROGRESS VIDEOS AND PHOTOGRAPHS

A. Progress videos and photographs shall include the date and time marking of the recording.

B. A minimum of twenty-five (25) videos/photographs shall be submitted with each request for payment. The view selections will be as approved by the Engineer.

1.04 FILE FORMAT, MEDIA AND SUBMITTALS

A. Photographs shall be in "jpg" format.

B. Videos shall be in a format viewable by Microsoft Windows Media Player or Apple QuickTime Player. Audio narration is desirable.

C. Files shall be named such that what is being viewed is self evident.

D. Files shall be submitted on a compact disk (CD) or a digital video disk (DVD). If submitted on DVD, disk shall be recorded in "Minus R" format.

E. The pre-construction videos and photographs shall be submitted to the Engineer within twenty-five (25) calendar days after the date of receipt by the Contractor of Notice to Proceed. Post-construction videos and photographs shall be provided prior to final acceptance of the Project.

F. Construction photographs shall be submitted with each payment request. Failure to include photographs may be cause for rejection of the payment request.

END OF SECTION 01320

SECTION 01350
PROJECT DOCUMENT TRACKING AND CONTROL SYSTEM

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall utilize the Owner's Project Document Tracking and Control System (DTCS). The primary function of the system is to facilitate timely processing and approval of all contract documents in coordination with the overall Project Schedule established by these Specifications and the Contractor. This system will utilize Skire Unifier for document tracking and control and Lynx Photo Management software. The Skire Unifier software will:

1. Facilitate communication among the Owner, Engineer and Contractor.
2. Facilitate turn-around time with regard to responses and approvals.
3. Provide a central location for all Project information to facilitate all Project participants in performing their tasks based on the latest Project data.
4. Provide a standard system of project administration with accountability.

B. The Contractor shall be required to utilize the web-based DTCS system that resides on the Department of Watershed Management server to generate documents in the proper format for submission to the Owner. The Contractor shall access the system through the internet using a compatible web browser from the Contractor's administrative field office location, and/or other locations where work associated with the Project is being performed.

C. The Contractor shall be required to generate Project documents and records utilizing the aforementioned system. The Contractor shall be required to transmit and submit the Project documents within the system to the Owner.

D. The Contractor shall utilize a high capacity scanner capable of scanning 11 x 17 documents, double sided, on site for the entire duration of the Project. All documents must be scanned in and attached to the appropriate Skire Unifier document, including submittals, shop drawings, O&Ms, Record Agreement Documents (As-built Drawings and Specifications), and all other documents requested by the Engineer.

E. The Contractor shall utilize the DTCS to create and maintain Project documents, including, but not limited to the following:

1. Company Directory: Addresses, Phone Numbers, Personnel Contacts, etc.
2. Drawings Log: Current Drawing revision log.
3. Submittals (Integrated with Project Schedule through Activity codes).
4. Transmittals.
5. Requests for Information and Answers (RFIs).
6. Change Documents, Including:
   a. Requests for Proposal (RFPs).
   b. Work Authorizations (WAs).
   c. Change Order Requests (CORs).

d. Change Orders (CO).
e. Design Clarifications (DC).

7. Daily Reports (Daily Diaries).
8. Field Decisions and Clarification Memos.
9. Notice of Non-Compliance.
10. Construction Issue Memos.
11. Punchlists.
12. Meeting Minutes and Agendas.
13. Correspondence.
14. Work Plans.
15. Start-up Plans.
16. Equipment Operation and Maintenance Training.
17. Spare Parts.
18. Record Agreement Documents (As-built Drawings and Specifications).

F. The Contractor shall utilize the complete capabilities of the DTCS to meet the requirements of this Section. The Contractor shall provide a highly trained and experienced construction project controls person knowledgeable in construction work sequencing, productivity, scheduling, and application of the Skire Unifier software system. This person, along with the Contractor's management team, shall work closely with the Owner to deliver the documents outlined in this Section.

G. Software Support

1. The Contractor shall provide for a one day training class for the Lynx PM software for ten personnel, seven for Owner and three for the Contractor. The type of class shall be determined by the Owner. The Contractor may contact Lynx PM Representative at 1-877-955-7711.
2. The Contractor shall provide twenty (20) Lynx Licenses (ten (10) User Master Enterprise License and ten (10) User Enterprise Remote License).
3. The Contractor shall purchase ten (10) additional licenses of the Skire Unifier software on behalf of the Owner for use during the project. At project closeout, the licenses will remain with the Owner.
4. The Contractor shall be required to establish an internet connection using a Digital Subscriber Line (DSL) or better to connect to the DTCS to permit the forwarding and receipt of documents.
   a. The Skire Unifier software supports the following Email programs, and the Contractor shall utilize:
      i) Microsoft Outlook 2003.
      ii) Microsoft Outlook 2007.
   b. The Contractor shall also provide two (2) days of consulting services in the base bid for troubleshooting and maintenance of the DTCS at any location designated by the Owner or at the Contractor's administrative field office (if authorized by the Owner).

Troubleshooting, maintenance, upgrade, configuration, and set up shall be performed by Skire Unifier or their authorized consulting service representative based on a scope pre-defined by the Owner. The Contractor shall utilize the custom data fields, dictionaries, and coding systems as required by the Owner.

H. The Contractor shall be required to attend a 2-day training session on the operation of the Owner's DTCS, provided by a Skire Unifier Authorized Trainer. The Contractor shall provide the training session for ten (10) participants (fee for the Skire Unifier Owner Authorized Trainer). The training session shall be held at the Owner authorized consulting service facility or Owner facility and shall be attended by the Contractor (limited to three (3) participants) as well as representatives of the Owner (seven (7) participants). The Contractor shall be responsible for the cost of training for additional members of their firm or future retraining, as may be deemed necessary by the Contractor.

I. The Contractor shall meet with the Owner within fifteen (15) days after the Contract is awarded to discuss access requirements and the Contractor's plan to utilize DTCS and execute the document control functions herein.

J. Access through the internet to the DTCS shall be operational within thirty (30) days following the pre-construction meeting date. This must be operational from the Contractor's administrative field office location.

1.02 COMPANY DIRECTORY

A. The Contractor and the Owner will monitor and manage the Company Directory. The directory must include Company name, Company abbreviation, contact names, address, phone numbers, and e-mail addresses.

1.03 DRAWING LOG

A. The Owner will maintain a log of initial "issued for construction" drawings in the DTCS. Information shall include drawing number, title, and revision number. In addition to logging the initial project drawing list, the Owner will maintain a log on the DTCS of all subsequent revisions to these drawings and any sketches resulting from clarification memos, RFIs, field orders and Change Orders. It is the Contractor's responsibility to utilize the latest drawings and sketches in the performance of the Work.

1.04 SUBMITTALS/SHOP DRAWINGS

A. Requirements: This section specifies supplemental requirements to GC-28, related to the processing of submittals and shop drawings. The Contractor shall utilize the DTCS to log and track submittals, as well as generate associated transmittal letters.

B. Submittals and Product Data: A list of all required submittals will be entered into the DTCS by the Contractor. Submittals shall be incorporated into packages, with the submittal numbering format to be provided by the Owner's Engineer. The Contractor shall log and track all submittals utilizing the DTCS. Each review cycle shall be entered into the DTCS. The Contractor shall identify as activities in the CPM schedule, specified in SC-16, to include all data submittals, as well as those involving complex reviews and long lead deliveries, and all procurement items required for construction activities. Submittal schedule information shall be updated monthly with the Contractor's updated project CPM schedule, as specified in SC-16.

C. Samples: A list of all required sample submittals shall be entered into the DTCS by the Contractor. Sample submittals shall be identified as individual submittals within the submittal packages with numbering as specified above.

D. Guarantees/Warranties: A list of all required Guarantee/Warranty submittals shall be entered into the DTCS by the Contractor. These submittals shall be identified as individual submittals within the submittal packages with numbering as specified above.

E. Work Plans, Start-up Plans, O&M Submittals, and Spare Parts: All testing, Start-up, and O&M submittals shall be entered into the DTCS by the Contractor. These submittals shall be identified as individual submittals within the submittal packages identified with numbering as specified above.

F. Submittal Procedures: The Contractor shall prepare all submittal packages utilizing the submittal numbering system, description, and packaging conventions described above. Submittals prepared by the Contractor, which fail to follow the conventions described above, will be returned to the Contractor to "amend and resubmit". Should the Contractor determine that a submittal is required but is not covered by the listing within the DTCS, the Contractor shall consult with the Engineer to determine whether the submittal is required, and if so, obtain submittal number, description, and packaging required.

1.05 CORRESPONDENCE

A. The Owner will monitor and manage the correspondence, Non-Compliance Notices, Field Decisions & Clarification Memos, and Construction Issue Memo logs. The Contractor shall generate Project correspondence within the DTCS, and forward the correspondence to the Owner.

1.06 TRANSMITTAL LOG

A. The Contractor and the Owner shall monitor and manage the transmittal log. All Project transmittals shall be created electronically, automatically sequentially numbered and logged into the DTCS system as they are created. The Contractor shall utilize the DTCS system to create transmittals for items transmitted to the Owner, Engineer, Resident Inspection Staff, and other contractors.

1.07 REQUEST FOR INFORMATION AND ANSWERS

A. The Contractor shall be responsible for generating RFIs on the DTCS system. The Contractor shall notify the Owner when an RFI is submitted. The Owner will monitor and manage the RFI log. The Engineer will generate an Answer document in response to each RFI and forward them to the Contractor. The DTCS will track "Ball in Court" for all RFIs and Answers, as well as date of original generation and response date. In addition the RFIs will reference the relative Specification Section and Drawings. The DTCS will identify the date of the request and the originator, responsible party for a response, and the date of the response.

1.08 CHANGE DOCUMENTS

A. Change documents include Request for Proposals (RFPs), Work Authorization Requests (WARs), Work Authorizations (WAs), Change Orders Requests (CORs), Design Clarifications (DC), and Change Orders (COs). All change documents will be monitored and managed by the Owner utilizing the DTCS. The DTCS will track "Ball in Court" status of all change documents.

1.09 DAILY REPORTS

A. The Contractor shall create daily reports (daily diaries) utilizing the DTCS. The Contractor shall enter the Daily Reports into the DTCS by 10:00 a.m. of the subsequent day that the Contractor or any subcontractor performs work. All daily reports shall be logged into the DTCS by the Contractor. The Contractor shall also provide one signed hard copy of all daily reports to the Owner on a weekly basis. Required information shall include Contractor, Date, Day, Temperature, Precipitation, Sky, Wind, Work Activity, Equipment, Field Force, Visitors, Materials, and Scheduled Activities utilizing the Primavera schedule activity codes. Daily reports which fail to link work activities to the active Primavera schedule will not be acceptable.

1.10 PUNCHLISTS

A. The Owner will monitor and manage punch lists, and will create Punchlists to be forwarded to the Contractor. The Contractor shall address the Punchlist items that have been assigned to the Contractor and forward updates to the Owner. Once accepted as complete, the Owner will access the punchlist in the DTCS and close it out.

1.11 MEETING MINUTES AND AGENDA

A. The Owner shall monitor and manage the meeting minute process. The Owner will forward meeting minutes to the Contractor electronically. The Owner will log the meeting minute items into the DTCS within three (3) days of the meeting date.

1.12 PROGRESS PAYMENTS / REQUISITIONS FOR PAYMENT

A. The Contractor shall for prepare progress payment applications directly from the Primavera scheduling software and then forward them to the Owner electronically along with hard copies by 4:00 p.m. at the end of each update/billing period. The Contractor shall also simultaneously provide a separate submittal of the updated Primavera progress schedule (P6 or latest version at the time of purchase), as specified in SC-16. All Progress Payments and schedule of values shall be developed as defined in the Special Conditions Required information within the Pay Application shall be coordinated with the Owner's Project Manager. Maintenance of the "As Built" record documents by the Contractor shall be verified before processing will be approved. Failure of a Contractor to maintain project record documents, maintain current and properly prepared daily reports or to submit the project schedule update per SC-16 will be just cause for withholding of the monthly or final payment.

1.13 LYNX PHOTO MANAGEMENT SOFTWARE

A. The Lynx PM software shall be utilized by the Owner and the Contractor for the duration of the project. The daily construction photographs will be the permanent visual record of the pre-construction conditions, daily construction site activities, and the completion of construction work. The Contractor must submit to the Owner no less than four (4) record photos for each activity ID listed in the project schedule per the last schedule update. Applicable photos must accompany each Pay Application.

1.14 RECORD AGREEMENT DOCUMENTS (AS-BUILT DRAWINGS & SPECIFICATIONS)

A. General - This section specifies supplemental requirements to GC-28.4

1. Record Agreement Documents (As-Built documents) are the amended "Conformed Drawings and Specifications" revised to show the Project as constructed by the Contractor. The revisions from Working Red-line Record Drawings shall ultimately be transferred to the final as-built set of drawings in AutoCAD format by the Contractor.
2. The Engineer will provide the Contractor with two (2) complete sets of printed Contract documents (Drawings and Specifications) specifically for the Contractors use for maintaining Working (Red-line) Record Documents. The Engineer will also provide the Contractor with one CD containing a complete set of the electronic Contract drawing files in AutoCAD format, for the Contractors use in providing finalized record drawings in AutoCAD format.
3. The Contactor shall submit to the Engineer on a monthly basis As-Built Drawings indicating work in place and changes to Contract Drawings for the previous month. The Monthly As-Built Drawings will be part of the documentation required for review and approval of Monthly Progress Payments.
4. At the point of substantial completion of the Project and before any release of retainage is granted, the Contractor shall furnish the Engineer with the following documents for review and approval: One (1) complete set of Working (Red-line) Record Drawings.
5. At the point of final completion of the Project, and before final payment is made, the Contractor shall furnish the Engineer with the following documents for review and approval: One (1) complete printed full size set, and one (1) complete printed half size set, of finalized Record Drawings and Specifications; and one (1) complete set of finalized electronic Record Drawing files in the latest AutoCAD format and one (1) complete set in PDF format, reflecting all Working (Red-line) changes herein described.

B. Reference Coordinate System:

1. The Contractor shall use the same reference coordinate system provided on the Conformed Drawings when modifying the Drawings as required under GC-28.4.
   a. The horizontal position of all points shall be referenced to the North American Datum of 1983 (1986 adjustment) in the Georgia State Plane West 1002 Coordinate System.
   b. The vertical position of all points shall be referenced to the North American Vertical Datum of 1988.
   c. All coordinate values shall be delivered as grid coordinates in US Survey Feet.
   d. GPS data shall be collected using eGPS Solutions or equivalent internet-based real time GPS network. The network shall provide continuous error correction and accuracy. The Contractor shall use high accuracy GPS equipment that is manufactured for and capable of producing survey-grade coordinates that are suitable for use in engineering design and hydraulic analyses.
   e. The minimum data accuracy required for all as-builts is +/- 0.10 USFT (one tenth of a foot).
   f. Any transformation or adjustment necessary to re-project surveyed coordinates to the Reference Coordinate System will be the responsibility of the Contractor, at no additional cost to the Owner.

g. The locations of all piping and structures shall be verified using GPS technology and designated on the Working Record Drawings using State Plane Coordinates.

C. Working (Red-line) Mark-up Document Requirements:

1. The Contractor shall keep and maintain the following Record Documents at the site of the work in good order to track changes, additions, or deletions from the original design during construction: (1)two (2) sets of Drawings and Specifications; and (2)one (1) set of all other Agreement Documents, reference documents, and all technical submittals. The Working Record Documents shall be up-dated and kept current on a continual basis by the Contractor. The redline Working Record Documents will be reviewed monthly by the Engineer prior to approval of the Contractor's Application for Payment. Failure to maintain the red-line Working Record Documents in a satisfactory manner shall be cause for rejecting the monthly Application for Payment.

2. For all projects, the two (2) sets of Working (Red-line) Record Documents shall include all changes to the Conformed Plans and Specifications including but not limited to the following:
   a. Where Contract Drawings and/or Specifications present options, only the option selected for construction shall be shown on the Final As-Built Documents. The Contractor shall cross out such words and phrases as "optimal requirement," "or equal," etc., and list specifically the items of materials provided.
   b. Obstructions not shown on the Drawings that are encountered on the site of the work during construction.
   c. Changes in details of design or additional information obtained from shop drawings specified to be prepared and/or furnished by the Contractor; including but not limited to fabrication, erection, installation plans and placing details, pipe sizes, insulation material, dimensions of equipment foundations, etc.
   d. Differing topography, invert elevations and grades of drainage installed or affected as part of the project construction.
   e. Approved systems modifications installed by the Contractor, such as HVAC controls, fire alarm, fire sprinkler, and irrigation systems.
   f. Changes or modifications that result from the final inspection.
   g. Changes issued as Work Authorizations (WAs), Change Orders, Design Clarifications (DCs), responses to Requests for Information (RFIs), Field Variance Directives, or Jobsite Memos.
   h. Any additional details needed for the construction of the Project but not shown on the Conformed Design Drawings.
   i. RFIs, DCs, and Field Variance Directives shall be posted in such a manner so as to clearly identify the following information about each:
      i) The RFI/DC/Field Variance Directive number.
      ii) The Date of the RFI/DC/Field Variance Directive.
      iii) The full question and answer.
      iv) Any sketches that accompany the RFI/DC/Field Variance Directive that reflect changes (additions or deletions) to the drawings.
   j. Any substructures, not shown on the Drawings, encountered while excavating, or substructures that are left in place shall be located by survey to the satisfaction of the Engineer.

k. All substructures including, but not limited to, concrete structures, electrical conduits and duct banks, drains and sanitary sewer pipelines, process piping, water lines, etc, whose installed location differs from that shown on the Conformed Drawings shall be precisely located by survey to the satisfaction of the Engineer and recorded on the Working Red-line Drawings before backfilling.

l. The actual locations, kinds and sizes of all of existing utilities uncovered or located by the Contractor, where locations on the Drawings are not correct, and any utility lines that are added or modified, within the construction area. Measurements shall be shown for all change or direction points and all surface or underground components such as valves, manholes, drop inlets, clean outs, meters, etc. The descriptions of exterior utilities shall include the actual quantity, size, and material of the utility lines. In order that the location of these lines and appurtenances may be determined in the event the surface openings or indicators become covered over or obscured, the Working Red-line Drawings shall show, by offset dimensions to two permanently fixed surface features, the end of each run including each change in direction. Valves, splice boxes, and similar appurtenances shall be located by dimensioning along the utility run from a reference point. The average depth below the surface of each run shall also be recorded.

m. The location and dimensions of any changes within the building structure.

n. Layout and schematic drawings of phone lines, gas lines, water lines, sewer lines, electrical lines, piping, ductbanks, and associated handhole and manholes, and pullboxes, junction boxes, and terminal boxes uncovered or located by the Contractor, where locations on the Drawings are not correct and any that are added or modified within the construction area.

o. Correct dimensions and details transferred from shop drawings.

p. Correct grade, elevations, cross section, or alignment of roads, earthwork, structures or utilities if any changes were made from Drawings.

q. Actual locations of anchors, construction or control joints, etc., in concrete.

r. Changes in location of equipment and architectural features.

s. All tables and schedules included in the drawings, for any discipline, shall be updated to reflect the as-installed condition.

3. Working (Red-line) Record Drawing Requirements for sewer line projects and work scopes (storm and sanitary). The Contractor shall provide detailed mark-ups of the Conformed Contract Drawings, or additional detailed drawings, as required to reflect the following information:

a. Provide the as-installed sewer plan and profiles.

b. Show the as-installed sanitary profiles with material, size, length, slope, inverts, manhole numbers/designation, station, manhole diameters, and rim elevation. Call out sections that are micro-tunnel, tunneling, and/ or jack and bore. The contractor shall include an Excel sheet listing the manhole with number, size, coordinates, and clean-out locations with coordinates.

c. Label laterals based on street address and include station. Lateral information shall include but not be limited to: Station, wyes, bends, street address, and length of pipe.

d. Show stationing in plan and profile view.

e. Show distance between new sanitary sewer and existing combined sewer or trunk sewer when running parallel to one another when the existing sewer location has been

verified.

f. Provide coordinates for manhole in plan view.

g. Show new storm line information (inverts, material size, and top) in plan view.

h. Label drainage structure installed in plan view; e.g. type of structure installed (Type B etc.)

i. Any change in alignment of the proposed sewer pipe, or when proposed manholes are moved to a new location, or any other change occurs in the field, the working (Red-line) Record Drawing must reflect these changes accurately. The old alignment or obsolete information shall be marked out.

j. Any change to the proposed slope of the sewer pipe must be reflected accurately in the profile: i.e., the invert elevation, stations, slope percent, pipe length should be revised as needed.

k. Show clean out locations in plan views to include station and coordinates.

l. Call-out inverts or top elevations and provide GPS coordinates at all utility crossings in profile view for mains only including size and material type.

m. Identify all sewers/manholes abandoned in place.

n. Call-out hand--tunnel and jack and bore shafts in plan view (either by note or actual location) that was left in place and greater than 5 ft. in depth.

o. Provide a general note stating who the pipe manufacturer is, the class of pipe, material type, joint type, and lining.

D. Working Drawing (Red-Line) Mark-up Guidelines / Requirements:

1. Marked-up changes on the prints shall be complete and understandable.

2. The Contractor shall use three base colors in marking up the hard copy of the working as-built drawings as follows.
   a. Deletions (Red) - Deleted graphic items (lines) shall be colored red with red lettering in notes and leaders.
   b. Additions/As-built Notations (Blue) - Added items and As-built information shall be drawn in blue with blue lettering in notes and leaders.
   c. Special (Green) - Items requiring special information, coordination, or special detailing or detailing notes shall be in green.

3. The Contractor shall use written explanations on Record Red-Line drawings to describe changes (do not rely totally on graphic means to convey the revision).

4. Legibility of lettering and digit values shall be precise and clear when marking documents, and clarify ambiguities concerning the nature and application of change involved.

5. Wherever a revision is made, the Contractor shall make changes to affect related section views, details, legend, profiles, plans and elevation views, schedules, notes and call-out designations, and mark accordingly to avoid conflicting data on all other sheets.

6. When changes are made, the Contractor shall cross out all features, data, and captions that relate to that revision that are being deleted or changed.

7. When changes are required on small-scale drawings and in restricted areas, large-scale inserts shall be drawn or sketched, with leaders to the location where applicable.

8. The Contractor shall be sure to add and denote in legend, any additional equipment or material facilities, service lines, etc., incorporated under as-built revision if not already shown in legend.

9. When attached prints (or sketches) are provided with marked-up print, the Contractor shall indicate whether:
   a. Entire drawing shall be added to the Original Conformed Design Drawings or
   b. Whether the Original Conformed Design drawings shall be changed to agree, or
   c. For reference only to further details not required for initial design.

10. The Contractor shall make the comments on the drawing complete without reference to letters, memos, or materials that are not also a part of the Red-line Working drawing. For example, annotating the drawing, "Per Work Authorization #42," is not acceptable when the actual Work Authorization states, "Added an additional 12 ea. duplex outlets" or similar statements.

11. The Working Drawing Red-Line shall be on black line prints of the most current sheet.

12. Shop drawings shall be incorporated into the Working Drawing Red-Line. The Contractor shall ensure its suppliers provide Shop Drawing submittals in electronic CADD file format that conform to the United States National CAD standard, latest version. Hand drawn or plotted paper shop drawings will not be accepted as part of a vendor submittal or for the Working Drawing Red-Line or the final record document drawings unless accompanied by the electronic AutoCAD file in the proper format.

13. Any drawing provided by non-COA sources will be drawn in AutoCAD. Sheets shall be drawn at the same scale as similar drawings in the set (example: Fire alarm systems shall be drawn to the same scale as the plumbing or electrical drawings). The drawing shall meet the same standards required for the rest of the "As-Designed" drawing set. Sheet number, detail number, etc shall tie details and sketches to existing drawings. The vendor shall be provided with the Contract CAD drawings as a base for the shop drawing

14. The sheet index shall be updated if any sheets are added or the sheet name has been modified.

E. Final AutoCAD Record Drawing Requirements:

1. The Contractor shall hire an experienced engineering firm, approved by the Engineer, to incorporate all the Redline Changes to the AutoCAD Record Drawings.

2. The Working (Red-Line) drawing changes made throughout the course of the project shall be incorporated electronically into the AutoCAD set. The changes recorded electronically into AutoCAD shall be done in a neat and workmanlike manner, similar to the AutoCAD drawings as originally provided to the Contractor by the Engineer. The Final AutoCAD Record Drawings shall conform to the standards of the original Design drawings provided.

F. Final Record Drawing AutoCAD Drafting Standards:

1. Standard professional engineering drafting practices shall be utilized in correcting the original electronic AutoCAD drawings to show as-built conditions. In general, the letter styles, line thickness, and scale shall be the same as the original drawings. Any additional sheets added shall conform to the standards of the original Design drawings provided, and the United States National CAD standard, latest version.

2. CADD Standards: File Naming Convention will be maintained on all existing CADD files and followed for any new files added. The Contractor shall revise CADD files as-built drawing layers, to show the as-built conditions during the prosecution of the project. All as-built "triangle" changes shall be on a separate single layer, using a single color, with an associated medium pen width for example:

   Level Number: 63
   Level Name: ANNO-REVS
   Level Description: Revisions

3. The following specific requirements apply to the preparation of the Record (As-built) Drawings:
   a. As-Built Stamp: When final revisions have been completed, the cover sheet drawing shall show the wording "RECORD DRAWING AS-BUILT" followed by the name of the Contractor and project completion date in letters at least 3/16 inch high. All other contract drawings shall be marked in the bottom right-hand corner of each drawing either "RECORD DRAWING" denoting no revisions on the sheet, or "REVISED RECORD DRAWING" denoting one or more revisions. Original contract drawings shall be dated in the revision block.
   b. Revisions Block Entries: Those sheets, which have no changes, will only be labeled RECORD DRAWING as described above. Those sheets which have changes shown on them will have REVISED RECORD DRAWING entered in the first available space. This will be revision one and a number 1 will be entered in the triangle at the beginning of that line. In the event the sheet has already been revised and a number and revision appear in the revision lines, the next sequential number will be used. Normally the first entry is made in the first line. The completed Record Drawing original CADD file drawings shall be reviewed for accuracy and initialed by the Contractor prior to submission to the Engineer.
   c. Revision Annotations:
      i) Deletion - to show an item was not installed, remove the item from the drawing along with any associated devices, connecting lines, ducts, pipes etc., including notes and dimensions. To show a detail is not being used, remove the detail
      ii) Notes - remove any notes that are no longer applicable. Modify as needed remaining notes to reflect actual conditions.
      iii) Additions - show a new or additional item or items and associated connections made if the print indicates such connections.
      iv) Relocations - draw the item in the new location and erase it from the old location. All connections will be transferred if applicable, such as wiring, piping, and ducts.
   d. Sentence Tense: Changes to Record drawings shall not include text changes that are tense changes, for example, "EXISTING GROUND LINE" to "ORIGINAL GROUND LINE"; "SHALL BE REMOVED" to "REMOVED."
   e. Drawing continuity: The applicable drawings shall be marked-up when a change is made. Final responsibility for drawing continuity is with the person doing the Record Drawing. When one floor plan indicates a wall, room, doors, etc., has been changed, the same change shall be made on all other applicable drawings. When the change is applicable to only one discipline such as electrical and does not directly affect other discipline sheets, a note may be added to other discipline sheets such as "See sheet _____ for As-built Record Conditions."

f. Shop drawings: The shop drawing information shall be incorporated into the original contract drawings. When shop drawings are added to the original contract drawing set they need to be appropriately labeled with the established file numbering convention, discipline, and sequence sheet number. The Index of Drawings shall be revised to show the additional sheet(s) with the appropriate sheet title. In the case where the shop drawing is smaller than the standard sheet size (i.e. 8.5"x11" or 11"x17" or 24"x36" etc.) the sheets will be cut into a standard sheet size border sheet and appropriately labeled. (For additional information refer to Working Drawing Mark-up Guidelines, Shop drawings above.)

END OF SECTION 01350

SECTION 01351
COMMUNICATIONS & PUBLIC RELATIONS

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall provide all personnel, services and materials as specified under this Section necessary to meet the requirements and responsibilities related to the Office of Communications & Public Relations and the Customer Services Manager, as specified hereinafter, during performance of Work under the Agreement by the Contractor.

1.02 STAFFING

A. The Contractor shall employ a full time Customer Services Manager (CSM) meeting the required minimum qualifications and experience below. The sole and specific duties and job of the CSM shall be to perform Customer Service related functions and to continuously coordinate and provide information and services as required to the City's Construction Manager, Office of Communications staff and others as necessary.

B. CSM must have been employed on at least two (2) satisfactorily completed sanitary sewer projects.

C. CSM must have had the responsibilities of receiving, logging, tracking, responding and resolving customer/citizen complaints and claims, providing notices to and personal interaction with affected customers/citizens regarding project impact and projected work schedules of the Contractor, reviewing project schedules and "look-ahead" to determine projected areas of impact from the Work.

D. CSM must have a minimum of two (2) years of experience in performing this type of work on similar projects.

E. CSM shall attend a mandatory public outreach training session presented by the City of Atlanta Office of Communications & Public Relations.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PUBLIC OUTREACH KICK-OFF MEETING

A. Prior to commencement of Work under the Agreement and following the preconstruction meeting, the Contractor, the CSM and the Engineer will be required to attend a public information meeting hosted by the Office of Communications & Public Relations. At this meeting the Contractor's responsibilities will be discussed, the relationship with the Office of Communications & Public Relations, the Engineer and/or designated representative of the City regarding the functions and responsibilities of the CSM employed by the Contractor as required under Section 1.02 A, above. The Contractor's CSM and backup individual shall be identified to Office of Communications administrative assistant and the Public Information Manager (PIM) with 24/7 contact telephone numbers provided.

3.02 RESPONSIBILITIES OF THE CSM

A. The duties of the Contractor's CSM are defined below and may be expanded by the City's Construction Manager as needed. Responsibilities of the Contractor's CSM shall include, but not be limited to, the following elements.

B. Receiving, logging, tracking and resolving customer/citizen complaints and claims; either received directly, by the City or its authorized representative and providing periodic updates and reports as specified.

C. Providing notice to affected stakeholders in the event there are scheduled service outages or other work elements required for the performance of Work under the Agreement that are scheduled which will have an impact on the neighborhood or property owners.

D. Attendance and participation in scheduled project progress meetings for discussion, updates and resolution to customer/citizen complaints, claims, review of schedules and other matters as required.

E. Attendance and participation in periodic public meetings. Work with the PIM to prepare necessary documents for distribution in advance of these meetings.

F. In the event work is required on private property where an easement has been acquired, the CSM shall notify the property owner at least fourteen (14) days in advance of commencement of the work in writing, a copy of which must be provided to the Office of Communications.

G. Prior to commencement of work in any neighborhood, the CSM shall provide notice to the PIM and at the PIM's direction and with their coordination, notice the customers/citizens thirty (30) days in advance. In addition, twenty-four (24) hours prior to actual commencement of the work, the CSM shall notify the customers/citizens via door or mailbox hanger as hereinafter provided for in this Section. All such notices shall be coordinated with the City's Construction Manager and PIM.

H. The CSM will be responsible for managing those notifications within the context of the Project Schedule and the approved project procedures. The CSM will assist the City of Atlanta site staff with the resolution of any public outreach-related items that might delay or disrupt the project work.

I. The CSM shall be on twenty-four (24) hour call, seven (7) days a week and be equipped with a mobile phone. In the event of the CSM being away from work, the contractor shall designate a second individual to handle the responsibilities and functions who shall be fully familiar and aware of the duties and prosecution of the work

J. The Contractor/CSM must report and log in all complaints to Office of Communication's administrative assistant and the City's PIM within six (6) hours of receipt. Conversely, all calls received by the Office of Communications (404-546-3200) will be transmitted to the CSM within twenty-four (24) to forty-eight (48) hours of receipt and the CSM must perform follow-up within twenty-four (24) hours with resolution after receipt of the notice. Upon receipt of the information the Office of Communications will create a file to document the incident.

K. The Contractor's CSM must maintain a Project Complaint Log fully detailing all customer/citizen complaints/claims, questions and resolutions. All complaints/inquiries received in the field by the

work crew regarding the project must be documented by the CSM and entered into the Project Log, even if resolved immediately. This complaint log will be available to the City's Construction Manager and the PIM in its updated state for review or reference when needed. Log shall be submitted on a monthly basis with the progress payment request

L. Where property owners make damage claims, CSM shall coordinate the activities of the Contractor's, Subcontractor's or Vendor's insurance provider(s) during the investigation and repair process and obtain the complainant's signoff to conclude and close the file. The City shall be informed in writing upon resolution of any complaint by the Contractor or its designated representative and copied on the sign-off documents. The CSM shall track any and all insurance damage claims, payments, settlements etc., on the Project, whether they are the responsibility of General Contractor, subcontractors or disputed. This Damage Claim Log will be separate from the Complaint Log, but may be cross-referenced if the damage results in a complaint.

M. The CSM shall assist the Contractor's Traffic Control Officer in coordination of all street closures, detours and traffic pattern changes with the Contractor's field management staff, the City's Construction Manager, PIM and the Department of Public Works or the Georgia Department of Transportation (GDOT). The CSM will check the notice status with the Contractor's Traffic Control Officer each morning and confirm that notifications to the City of Atlanta's Traffic Control center are current and accurate for Police, Fire and Emergency vehicle access. The CSM will also assist in the coordination on the signal changes involved with temporary traffic plans.

N. As required, the CSM must provide notice to the affected areas in advance of the scheduled closures, detours and traffic pattern changes. This includes but is not limited to maintaining safe residential and business access, mail delivery and garbage pick-up, providing temporary and /or alternate services and relocation coordination for school bus, MARTA stops and any other temporary facilities needed to keep neighborhood safety, security and services within acceptable limits. All these items and the coordination of them will be required as part of the detailed work plans, site specific safety plans, traffic management plans, erosion and sedimentation plans and project schedules.

O. In the event there is an emergency involving the public or a situation where media inquiries and responses are possible, the City's PIM shall be notified immediately. The PIM will then coordinate with the City's Media Relations Manager for appropriate action. Under no circumstance shall the CSM, any employee, Subcontractor or Vendor of the Contractor make any comments to the media regarding the project at any time.

P. The Office of Communications is responsible for conducting media relations training and management with the on-site staff. Procedures will be developed within the site specific safety plan which sets up guidelines for managing any media response to an emergency issue and the entire site staff will be trained on them.

3.03 CUSTOMER SERVICE TRACKING SOFTWARE

A. The Office of Communications shall use "Footprints" by Unipress Software to track and enter information from customers/citizens regarding complaints, claims and inquiries. All related information shall be updated on a daily basis by the PIM. Tracking information and responses shall be coordinated with the PIM. Reports shall be provided as weekly updates on all activities and on specific cases within twenty-four (24) hours when requested.

B. Information recorded shall include but not be limited to the following:

1. Date complaint/claim/inquiry received.
2. Name, address and telephone number of individual filing complaint/claim/inquiry.
3. Nature of complaint/claim/inquiry.
4. Address where problem is located if different than above.
5. Action required, date, action taken, date action completed.
6. Follow-up with person who filed under 2 above to verify satisfaction or status.
7. Documents associated with actions taken.
8. Any information regarding resolution with the Contractor's, Subcontractor's or Vendor's Insurance Company shall be fully documented.

3.04 DOOR-HANGERS

A. The Contractor shall produce door hangers required for notice to customers/citizens and residents from the template provided by the City's PIM (SEE EXAMPLE AT END OF SECTION) as specified hereinabove in paragraph 3.02. Door hangers shall be utilized for notification in the event of, but not limited to, the following events:

1. Planned service disruption/outages
2. Road closures/detours/traffic pattern changes
3. Access/entrance to property
4. Work start-up
5. Smoke testing
6. Blasting

3.05 IMPACTED AREA ADDRESS DATABASE

A. The Office of Communications shall provide the CSM a database of addresses and phone numbers (and names if available) of all project impacted residences, businesses and facilities at least three (3) weeks prior to project start-up. The database will be used by the PIM & CSM for regular citizen communications and notifications.

B. The Contractor and Engineer shall copy the City's PIM on all correspondence and Right-of-Entry Agreements with citizens and property owners.

3.06 SCHEDULE

A. The CSM shall provide the PIM with a copy of the detailed project schedule following approval by the Engineer.

B. Bi-weekly, the CSM shall provide a list of properties:

1. That will be affected by the Contractor's activities within the upcoming 4 weeks;
2. Where work is ongoing in the right of way in front or in the back of the property;

3. Where site restoration activities are ongoing.

C. The Contractor shall inform the City's PIM through scheduled progress meetings and in writing of any project schedule changes or changes in "disruptive work" such as blasting, road closures, etc., that would have significant impact on citizens or require prior citizen notification. The CSM shall notify the PIM of any "disruptive" activities affecting the public that occur on the jobsite within 4 hours of their occurrence.

3.07 MEDIA RELATIONS AND JOB SITE INQUIRIES

A. As specified above in paragraph 3.01, only authorized persons shall release any information to media inquiries. The Contractor's field personnel shall at all times have project information cards available that will be provided to media and citizens if inquiries are made on-site. All inquiries shall be directed to the person referred to on the card and citizens shall be referred to the Office of Communications.

B. Project information cards shall be produced by the Contractor from the template provided by the PIM. A sample information card is provided at the end of this Section. Final language to be included on the Project Information Card will be provided at the preconstruction conference. (SEE EXAMPLE AT END OF SECTION)

3.08 VEHICLE SIGNS AND PROJECT SITE SIGNAGE

A. The Contractor shall place pre-approved magnetic signs on all job-site project vehicles. The signage template will be approved by the City PIM with the signs to be produced by the Contractor.

B. All project sites shall have pre-approved project signs which read in accordance with the Template provided as part of the Special Conditions Signs shall be produced by the Contractor. Some of the signs shall be mounted on moveable skids so they can be relocated as the project progresses on various streets in the basin. Sizes will vary, but all will be smaller than the 96"x 48" size project signs shown. Size shall be as directed by the Engineer. Contractor shall provide a minimum of 25 project signs. These sign are required in addition to the four City of Atlanta Project signs identified in the Special Conditions.

3.09 NOTIFICATIONS

A. The Contractor shall provide the following notifications to the PIM to facilitate their communication with affected citizens through automated phone message or mailers :

1. Anticipated work start date-must be three (3) weeks prior so PIM may send out two (2) week notice mailer.
2. Service disruptions - Notify PIM at least 72 hours in advance so that 48 hour notice automated phone message notice may be issued.
3. Street Closure or Partial Closure - Notify PIM at least 72 hours in advance to permit 48 hour automated phone message.
4. Significant work in neighborhood - Blasting, directional drilling, trenchless installation, open cut, etc.-notify the PIM at least 72 hours in advance to permit 48 hour automated phone message.

B. The Contractor shall provide the following door hanger notifications and the manpower to deliver them at a minimum:

1. Service disruptions- notice to citizens 24 hours prior to disruption.
2. Street Closure or Partial Closure- notify fire, police other emergency services and other authorities 24 hours prior to street closure.
3. Significant work in neighborhood- blasting, directional drilling, trenchless installation, open cut, etc.-notify citizens via door hangers 24 hours in advance.

C. The Contractor shall be fully responsible for notification to all emergency related services for detours, closures (partial or full) or traffic pattern changes and as such they must be detailed in their traffic control plan and implemented through the Contractor's Traffic Control Manager and per all permitting requirements.

D. The Contractor shall be fully responsible for distributing all notifications a minimum of 48 hours in advance of service outages for schools, nursing homes, hospitals, medical clinics, assisted living facilities or other types of facilities. Contractor shall also make personal contact with facility representatives no later than 60 minutes prior to the outage.

E. The Contractor shall at all times coordinate with the City of Atlanta PIM and Call Center to provide detailed schedules and street locations for service disruptions or street closures to ensure that Call Center is well equipped to provide adequate response to citizen inquiries.

3.10 RESOLUTION OF COMPLAINTS AND CLAIMS

A. Failure of the Contractor to resolve any legitimate complaint or claim filed resulting from the work performed under this contract, following notice in accordance with the General Conditions, may result in resolution of the complaint or claim by the City. The Contractor will be charged for the associated cost in accordance with the applicable General Conditions of the contract. No additional payment will be made to the Contractor for any costs associated with complaint or claim resolution, same being incidental to the various contract items which are bid. Failure to manage the issues and items adequately to minimize public complaints and impacts will be cause for increasing the retainage, withholding payment and/or Notice and Termination of the Contractor for cause if more than 10% of the noticed complaints or claims age past 30 days without decisive resolution and scheduling of recovery work.

SAMPLE DOOR HANGER

NOTICE OF SEWER SYSTEM IMPROVEMENT WORK

City of Atlanta
Department of Watershed Management

The City is pleased to announce that we are moving forward with plans to fix our sewer system to meet state and federal requirements.

We are now at the point where construction activities are about to begin on your street for the South River Capacity Relief Projects. These planned improvements will reduce the incidents of sewage backups, leaks and sanitary sewer overflows.

The particular work planned for your street is checked below.

- o OPEN-CUT CONSTRUCTION
- o TUNNELING
- o SMOKE TESTING
- o ROAD CLOSURES AND/OR DETOURS
- o OTHER _____

We will do our best to minimize any inconvenience to you. All personnel are required to wear Clean Water Atlanta identification badges. If you have any questions or concerns, please contact William Horton, the Public Information Manager for this project at 770-294-3240 or call the Clean Water Atlanta Help Line at 404-529-9211.

If you have any questions, please call the Department of Watershed Management Helpline at 404-529-9211.

SAMPLE PROJECT INFORMATION CARD – TRI FOLD

City will enter into an easement agreement with the owner. The City's real estate agents are currently negotiating access agreements with the affected property owners.

Sewer separation contractors may use different technologies to construct the new sewers; including open-cut and tunnel construction. Neighborhoods in the separation area will experience some disruption, such as partial or complete street closures, traffic rerouting, storage of materials and equipment near construction sites, brief interruptions in sewer service, dust and noise. The City will take every practical measure to reduce disruption during the sewer separation projects.

If you have any concerns about work in your area or would like additional information, you contact the Project Help Line at 404-529-9211 or visit the City's Public Information Office located at 290 M.L.K. Blvd., Suite 103. The office is open from 8:00 am to 5:00 pm, Monday through Friday.

City of Atlanta
Shirley Franklin
Mayor

City Council
Lisa Borders
President

Carla Smith
Kwanza Hall
Ivory Young
Cleta Winslow
Natalyn Archibong
Anne Fauver
Howard Shook
Clair Muller
Felicia Moore
C.T. Martin
Jim Maddox
Joyce Sheperd
Ceasar Mitchell
Mary Norwood
H. Lamar Willis

CLEAN WATER ATLANTA

Stockade Project Information Card

COMBINED SEWER OVERFLOW REMEDIATION PROGRAM

The federal Environmental Protection Agency and state Environmental Protection Division have approved the City's plan to eliminate water quality violations from combined sewer overflows (CSOs). This plan includes a combination of deep-rock storage tunnels, new treatment facilities and the separation of combined sewers in selected basins- Greensferry, McDaniel and the Stockade sub-basin portion of the Intrenchment Creek basin.

You live in the Stockade Basin. Work in this basin extends roughly as far south as Lester Avenue, as far east as Stovall Street (north of I-20) or Ormewood Terrace (South of I-20), as far north as Decatur Street and as far west as Boulevard. Sewer separation construction activities commenced on May 1, 2005 and are slated for completion by December 2007.

WHAT HOMEOWNERS MIGHT EXPERIENCE DURING SEWER SEPARATION

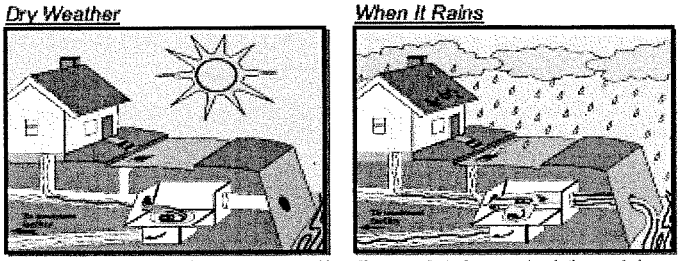
Most of the homes and businesses in the Greensferry, McDaniel and Stockade areas are connected to a combined sewer system. The combined system will be converted to a separated sewer system under the federal consent decree program. Sewer separation involves constructing new sanitary or storm sewers within a combined sewer service area. This allows wastewater and stormwater, currently collected in the same pipe, to be collected in separate pipes. The wastewater would be carried to an existing treatment plant where pollutants are removed before discharge to the South River. Separately treated stormwater would be collected and discharged to a local stream.

The Department of Watershed Management has been working with elected officials and community leaders to keep affected residents and business owners update about this project and to address specific neighborhood concerns.

Most of the existing combined sewers run beneath city streets but some were constructed in areas that are now private property. If a sewer is on private property and there is no existing easement, the

EXISTING COMBINED SEWER SYSTEM

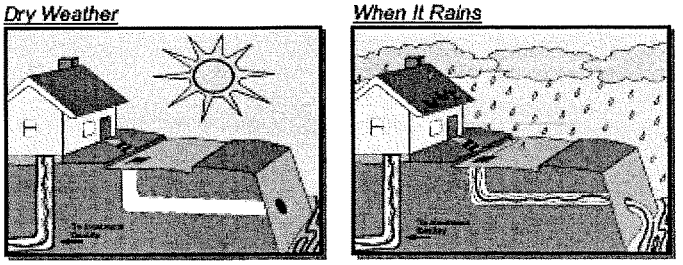
Dry Weather *When It Rains*



In a combined sewer system, domestic sewage combine with stormwater in the same pipe. In the event of heavy rains, the stormwater can cause an overflow into a receiving stream.

AFTER SEPARATION

Dry Weather *When It Rains*



In a separate sewer system, domestic sewage and stormwater flow into separate pipes. The sewage is diverted to a wastewater treatment plant and stormwater is released untreated to a receiving stream.

END OF SECTION 01351

SECTION 01400
QUALITY ASSURANCE/QUALITY CONTROL

PART 1 - GENERAL

1.01 SCOPE

A. This section includes requirements for the implementation of the Contractor's quality assurance and quality control program.

B. Related sections:

1. Section 01410 Testing Laboratory Services.
2. General Conditions.
3. Section 01600, General Equipment and Material Requirements.
4. Section 01664, Training.

1.02 REFERENCES

A. International Building Code 2006 (IBC).

1. IBC – Chapter 17 – Structural Tests and Special Instructions.

1.03 SITE INVESTIGATION AND CONTROL

A. The Contractor shall check and verify all dimensions and conditions in the field continuously during construction. The Contractor shall be solely responsible for any inaccuracies built into the Work due to the Contractor's failure to comply with this requirement.

B. The Contractor shall inspect related and appurtenant Work and report in writing to the Engineer any conditions that will prevent proper completion of the Work. Failure to report such conditions shall constitute acceptance of all Site conditions, and any required removal, repair, or replacement caused by unsuitable conditions shall be performed by the Contractor solely and entirely at the Contractor's expense.

1.04 INSPECTION OF THE WORK

A. All Work performed by the Contractor shall be inspected by the Contractor and non-conforming Work and any safety hazards in the work area shall be noted and corrective action shall be taken immediately. The Contractor is responsible for performing the Work safely and in conformance with the Agreement Documents.

B. The Work shall be conducted under the general observation of the Engineer and is subject to inspection by representatives of the Owner acting on behalf of the Owner to ensure strict compliance with the requirements of the Agreement Documents. Such inspection may include mill, plant, shop, or field inspection, as required. The Engineer shall be permitted access to all parts of the Work, including plants where materials or equipment are manufactured or fabricated.

C. The presence of the Engineer, however, shall not relieve the Contractor of the responsibility for the proper execution of the Work in accordance with all requirements of the Agreement Documents. Compliance is the responsibility of the Contractor. No act or omission on the part of the Engineer, shall be construed as relieving the Contractor of this responsibility. Inspection of Work later determined to be non-conforming shall not be cause or excuse for acceptance of the non-conforming Work.

D. All materials and articles furnished by the Contractor shall be subject to rigid documented inspection, by qualified personnel, and no materials or articles shall be used in the Work until they have been inspected and accepted by the Contractor's Quality Control representative and the Engineer or other designated representative. No Work shall be backfilled, buried, cast in concrete, covered, or otherwise hidden until it has been inspected and approved by the Engineer. Any Work covered in the absence of inspection shall be subject to uncovering. Where uninspected Work cannot be easily uncovered, such as in concrete cast over reinforcing steel, all such Work shall be subject to demolition, removal, and reconstruction under proper inspection at the Contractor's expense.

E. All materials, equipment, and/or articles furnished to the Contractor by the Owner shall be subject to thorough inspection by the Contractor's Quality Control representative before being used or placed by the Contractor. The Contractor shall inform the Engineer, in writing, of the results of said inspections within one working day after completion of inspection. In the event the Contractor believes that any material or articles provided by the Owner to be of insufficient quality for use in the Work, Contractor shall immediately notify the Engineer.

1.05 TIME OF INSPECTION AND TESTS

A. Samples required under these Specifications shall be furnished and prepared for testing in ample time for the completion of the necessary tests and analyses before said articles or materials are to be used. The Contractor shall furnish and prepare all required test specimens at the Contractor's own expense.

B. When the Contractor is ready to backfill, bury, cast in concrete, or otherwise cover any Work under this Contract, the Engineer shall be notified not less than three (3) Work Days in advance to request inspection before beginning any such Work of covering. Failure of the Contractor to notify the Engineer at least three (3) Work Days in advance of any such inspections shall be reasonable cause for the Engineer to order a sufficient delay in the Contractor's schedule to allow time for such inspection. The costs of any remedial or corrective work required, and all costs of such delays, including its impact on other portions of the Work, shall be borne by the Contractor.

1.06 SAMPLING AND TESTING

A. The Contractor shall retain and pay for an independent materials testing agency approved by the Engineer and the Owner per Article 1.07. The independent testing agency will develop and submit a testing plan for quality assurance on each type of work activity. The testing agency will document the processes and procedures utilized to verify and maintain quality work. When not otherwise specified, all sampling and testing shall be in accordance with the methods prescribed in the most current standards, as applicable to the class and nature of the article or materials considered. However, the Engineer reserves the right to use any generally accepted system of inspection which, in the opinion of the Engineer, will assure the Engineer that the quality of the workmanship is in full accord with the Agreement Documents. Copies of all test results are to be submitted to the Owner in a timely manner.

B. The Owner reserves the right to abbreviate, modify the frequency of, or waive tests or quality assurance measures. Waiver of any specific testing or other quality assurance measure shall not be construed as a waiver of any technical or qualitative requirements of the Agreement Documents. Whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the specified testing or other quality assurance requirements as originally specified, the waiver shall not be construed as a waiver of any technical or qualitative requirements of the Agreement Documents. Whether or not such guarantee is accompanied by a performance bond to ensure execution of any necessary corrective or remedial work, the waiver shall not be construed as a waiver of any technical or qualitative requirements of the Agreement Documents.

C. Not withstanding the existence of such waiver, the Owner shall reserve the right to make independent investigations and tests as specified in the following paragraph. Failure of any portion of the Work to meet any of the qualitative requirements of the Agreement Documents shall be reasonable cause for the Owner to require the removal or correction and reconstruction of any such Work.

D. In addition to any other inspection or quality assurance provisions that may be specified, the Owner shall have the right to independently select, or request a second test, and analyze, at the expense of the Owner, additional test specimens of any or all of the materials to be used. Results of such tests and analyses shall be considered, along with the tests or analyses made by the Contractor, to determine compliance with the applicable specifications for the materials so tested or analyzed. Wherever any portion of the Work is discovered, as a result of such independent testing or investigation by the Engineer, which fails to meet the requirements of the Agreement Documents, all costs of such independent inspection and investigation and all costs of removal, correction, reconstruction, or repair of any such Work shall be borne by the Contractor.

1.07 CONTRACTOR'S QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

A. The Contractor shall establish and execute a Quality Assurance/Quality Control (QA/QC) program for the services that are being procured from the Contractor. The program shall provide the Contractor with adequate measures for verification and conformance to defined requirements by his personnel and lower-tier subcontractors (including fabricators, suppliers, and sub-subcontractors). This program shall be described in a QA/QC Plan responsive to this Section. It shall utilize the services of an independent testing agency/company that is industry certified to provide QA/QC and compliance with the standards specified.

B. The Contractor shall furnish the Engineer a project specific QA/QC Plan. The Plan shall contain a comprehensive account of the Contractor's QA/QC procedures as applicable to this job. The Contractor shall furnish for review by the Engineer, no later than fourteen (14) days after receipt of the Notice to Proceed, the QA/QC Plan proposed to be implemented. The QA/QC Plan shall identify personnel, procedures, control, instructions, tests, records, and forms to be used. Construction will be permitted to begin only after acceptance of the QA/QC Plan. The detailed requirements for this QA/QC Plan are delineated in the following paragraphs. No payments will be made to the Contractor until the QA/QC Plan is approved by the Engineer.

C. The QA/QC Plan shall describe and define the personnel requirements described herein. The Contractor shall employ a full time on-site Field QA/QC Manager to manage, address, and resolve all QA/QC issues.

1. The QA/QC Manager shall be as identified by the Contractor and agreed to by the Owner. A resume for the potential QA/QC Manager shall be submitted to the Owner for review and approval. The QA/QC Manager shall have a minimum of ten (10) years of experience in the construction of water/wastewater treatment plant and/or conveyance system. The QA/QC Manager shall be onsite at all times while work is being performed by the contractor, to ensure that work is being performed properly and to routinely observe all Work in progress. This individual shall be responsible only for QA/QC activities and shall have no supervisor managerial responsibility other than the QA/QC. No change in the QA/QC Manager may occur without written consent of the Owner, and the prior approval of a replacement.

2. The Contractor shall provide additional personnel who are assigned to assist the QA/QC Manager fulfill the requirements of the QA/QC Plan. The Contractor shall provide a letter (to the QA/QC Manager) signed by an authorized official of the firm empowering the QA/QC Manager to address quality issues, and if necessary, to stop work which is not in compliance with the contract. The QA/QC Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities, and responsibilities. Copies of these letters shall also be furnished to the Owner.

D. The Contractor's QA/QC program shall ensure and substantiate quality throughout all areas of the contract. A customized QA/QC Plan shall be developed that discusses each type of work for which the Contractor is responsible within the Project. The QA/QC Plan shall describe the program, include procedures, work instructions, records, and a description of the quality control organization.

1. The description of the quality control organization shall include a chart showing lines of authority, staffing plan, and acknowledgment that the QA/QC staff shall implement the system for all aspects of the work specified. The staffing plan shall identify the name, qualifications (in résumé format), duties, responsibilities, and authorities of each person assigned a QA/QC function including the QA/QC Manager. In addition, the Plan shall describe methods relating to areas that require special testing and procedures as noted in the specifications.

2. This plan shall require a preparatory installation training, follow-up monitoring and ongoing observation of the work.
   a. The preparatory installation training class attendance will be required by the Contractor's and/or sub-contractor's crews before the start of each new construction activity. The Owner will attend and monitor the training. This training will consist of a hands-on demonstration of the work activities by the crews. The contractor crews shall demonstrate proper construction techniques in the performance of the work. No crews may begin work prior to successfully completing the preparatory installation training. This training will be monitored by the contractor's QA/QC Manager, Safety Manager and supervisory personnel. The QA/QC Manager shall submit a certification to the Engineer after each training session that the work crew have attended and successfully completed the training.
   b. The follow-up monitoring will take place no later than 10 days after the preparatory installation training. The follow-up monitoring will require the work crews to continue to demonstrate the proper means and methods of construction as performed in the preparatory installation training class. If in the sole judgment of the Engineer that the Work is not being performed as per the QA/QC Plan and/or the Agreement Documents, the crews shall discontinue the Work and will be required to attend the preparatory training class, again. The QA/QC Manager shall submit a certification to the Engineer after each follow-up training session that the work crews have continued to perform the

Work per the QA/QC Plan and/or Agreement Documents. Any retraining will be at no cost to the Owner.

c. Ongoing inspections will take place throughout the duration of the Project. The on-going monitoring will require the work crews to demonstrate the proper means and methods of construction as performed in the preparatory class. If in the judgment of the Engineer that the Work is not being performed as per the QA/QC Plan and/or the Agreement Documents the crews shall be required to attend the preparatory training class, again. Any retraining will be at no cost to the Owner.

E. Identification and Control of Items and Materials: Procedures to ensure that items or materials that have been accepted at the site are properly used and installed shall be described in the QA/QC Plan. The procedures shall provide for proper identification and storage, and prevent the use of incorrect or defective materials.

F. Inspection and Tests: The Contractor shall have written procedures defining a program for control of inspections performed and these procedures shall be described in the QA/QC Plan.

1. Inspections and tests shall be performed and documented by qualified individuals. At a minimum, "qualified" shall mean having performed similar QA/QC functions on similar type projects for a minimum of five (5) years and possession of industry standards certification and license. Records of personnel experience, training, and qualifications shall be submitted to the Engineer for review and approval.

2. The Contractor shall maintain and provide to the Engineer, within two working days of completion of each inspection and test, adequate records of all such inspections and tests. Inspection and test results shall be documented and evaluated to ensure that requirements have been satisfied.

3. Procedures shall include:
   a. Specific instructions defining procedures for observing all Work and comparing the Work with the Contract requirements (organized by specification section).
   b. Maintaining and providing Daily QA/QC Inspection Reports. Such reports shall, at a minimum, include the following:
      i) Dated list of Item(s) inspected.
      ii) Location of the test sample(s).
      iii) Logs, detailed location drawings and confirmation reports.
      iv) Quality characteristics in compliance.
      v) Quality characteristics not in compliance.
      vi) Corrective/remedial actions taken.
      vii) Statement of certification.
      viii) QC Manager's signature.
   c. Specific instructions for recording all observations and requirements for demonstrating through the reports that the Work observed was in compliance or a deficiency was noted and action to be taken.
   d. Procedures to preclude the covering of deficient or rejected Work.
   e. Procedures for halting or rejecting Work.
   f. Procedures for resolution of differences between the QA/QC representative(s) and the production representative(s).

g. Method of documenting QA/QC process and results including:
   i) Automatic exception reporting.
   ii) Resolution tracking.
   iii) Quality Confirmation Test reports.
   iv) Sample retention index and storage.

4. The QA/QC Plan shall identify all contractual hold/inspection points as well as any Contractor imposed hold/inspections points.

5. The QA/QC Plan shall include procedures to provide verification and control of all testing provided by Contractor including:
   a. Individual test records will contain the following information:
      i) Item tested – item number and description.
      ii) Test results.
      iii) Test designation.
      iv) Test work sheet including location sample was obtained.
      v) Acceptance or rejection.
      vi) Date sample was obtained.
      vii) Retest information, if applicable.
      viii) Control requirements.
      ix) Tester signature.
      x) Testing QC staff initials.
   b. Maintaining and providing to the Engineer Daily Testing Records. Such records shall, at a minimum, contain the following:
      i) Dated list of Item(s) inspected.
      ii) Location of the test sample(s) Logs, detailed location drawings and confirmation reports.
      iii) Quality characteristics in compliance.
      iv) Quality characteristics not in compliance.
      v) Corrective/remedial actions taken.
      vi) Statement of certification.

6. QA/QC Manager's signature providing for location maps/drawings (i.e. lift drawings, instrument loop sheets, laying schedules, etc.) for all tests performed or location of Work covered by the tests.

7. Maintaining copies of all test results.

8. Ensuring Engineer receives a copy of all tests directly from lab(s).

9. Ensuring testing lab(s) are functioning independently of Contractor in accordance with the specifications.

10. Ensuring re-tests are properly taken and documented.

11. Special Inspection and Documentation: In addition to the above inspection requirements, certain Special Inspection and Documentation requirements may be contained in the specification Sections. Perform Special Inspection and Documentation and submit a record showing results on an "as occurred" basis unless otherwise indicated.

12. The Contractor will employ separate qualified persons to provide Special Inspections required by reference 1.02 A., above, and as detailed in the Statement Special Inspections. The Contractor may employ an Independent Testing Laboratory (ITL), other inspection entities, or combinations of the above to perform Special Inspections.

G. Control of Measuring and Test Equipment: Measuring and/or testing instruments shall be adequately maintained, calibrated, certified and adjusted to maintain accuracy within prescribed limits. Calibration shall be performed at specified periods against valid standards traceable to nationally recognized standards and documented. Copies of measuring and / or testing instrument certifications shall be on file with the QA/QC Manager.

H. Supplier Quality Assurance: The QA/QC Plan shall include procedures to ensure that procured products and services conform to the requirements of the Specifications. Requirements of these procedures shall be applied, as appropriate, to lower-tier suppliers and/or subcontractors. QA/QC inspections and certifications may not be deferred to the Contractor's subs or suppliers.

I. Deficient, Defective, and Non-conforming Work; Corrective Action:

1. The QA/QC Plan shall include procedures for handling deficiencies and non-conformances. Deficiencies and non-conformances are defined as documentation, drawings, material, and equipment or Work not conforming to the specified requirements or procedures. The procedure shall prevent non-conformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent recurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documented and measures implemented to prevent recurrence. In addition, at a minimum, this procedure shall address:
   a. Personnel responsible for identifying deficient and non-complying items within the work.
   b. How and by whom deficient and non-compliant items are documented "in the field".
   c. The personnel and process utilized for logging deficient and non-compliant work at the end of each day onto a Deficiency Log.
   d. Tracking processes and tracking documentation for Deficient and Non-Compliant items.
   e. Personnel responsible for achieving resolution of outstanding deficiencies.
   f. Once resolved, how are the resolutions documented and by whom.

J. Special Processes And Personnel Qualifications:

1. The QA/QC Plan shall include detailed procedures for the performance and control of special process (e.g. welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).
2. Personnel performing special process tasks shall have the experience, training and certifications commensurate with the scope, complexity, or nature of the activity. They shall be approved by the Engineer before the start of Work on the Project.

K. Audits: The Contractor's QA/QC program shall provide for documented audits to verify that QA/QC procedures are being fully implemented by the Contractor as well as its subcontractors and suppliers. Audit records shall be made available to the Engineer upon request., Quarterly reports will be provided to the Owner indicating any outstanding and unresolved exceptions to the QA/QC program or Agreement Documents. This will include documentation on any standards

modifications, corrections, failed tests, and a review of field procedures and checks and balances effectiveness.

L. Documented Control/Quality Records

1. The Contractor shall establish methods for control of Agreement Documents that describe how Drawings and Specifications are received and distributed to assure the correct issue of the document being used. The methods shall also describe how as-built data are documented and furnished to the Engineer.

2. The Contractor shall maintain evidence of activities affecting quality, including operating logs, records of inspections and tests, audit reports, material analyses, personnel qualification and certification records, procedures, and document review records.

3. Quality records shall be maintained in a manner that provides for timely retrieval, and traceability. Quality records shall be protected from deterioration, damage, and destruction. The Contractor shall maintain an automated exceptions list of any non-conforming or defective or substandard work.

4. The Contractor shall provide a list with specific records as specified in the Agreement Documents to the Engineer at the completion of activities and in conjunction with logs and locational drawings.

M. Acceptance of QA/QC Plan: Engineer's review and acceptance of the Contractor's QA/QC Plan shall not relieve the Contractor from any of its obligations for the performance of the Work. The Contractor's QA/QC staffing is subject to the Engineer's review and continued acceptance. The Owner, at its sole option, without cause, may direct the Contractor to remove and replace the QA/QC representative. No Work covered by the QA/QC Plan shall start until Engineer's acceptance of Contractor's QA/QC plan has been obtained.

N. Engineer may perform independent quality assurance audits to verify that actions specified in Contractor's QA/QC Plan have been implemented. No Engineer audit finding or report shall in any way relieve Contractor from any requirements of this Contract.

1.08 TESTING SERVICES

A. All tests which require the services of a laboratory to determine compliance with the Agreement Documents shall be performed by an independent commercial testing firm approved by the Engineer as specified in Section 01410-Testing Laboratory Services. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped, and fully qualified to perform the tests in accordance with the specified standards. All standard quality assurance testing and installation verification testing will be at the expense of the Contractor.

B. Testing, when required, will be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

C. The Engineer shall have the right to inspect work performed by the independent testing laboratory both at the project and at the laboratory. This shall include inspection of the independent testing laboratory's internal quality assurance records (quality assurance manual, equipment calibrations, proficiency sample performance, etc.).

D. The Contractor shall obtain the Engineer's approval of the testing firm before having services performed, and shall pay all costs for these testing services.

E. Testing services provided by the Owner, if any, are for the sole benefit of the Owner, however, test results shall be made available to Contractor. Testing necessary to satisfy the Contractor's internal quality control procedures shall be the sole responsibility of the Contractor.

F. Testing Services Furnished By The Contractor: Unless otherwise specified, and in conjunction with, all other specified testing requirements, the Contractor shall provide the following testing services, and write up a detailed testing plan for each along with proposed forms for the Engineer's review:

1. Continuity and insulation megger testing.
   a. All Circuits.
   b. All Motors 25hp and greater.
2. Individual component calibration and testing.
   a. Instrument loop testing.
3. Calibration of fixed instruments.
4. Process / Mechanical/ Drainage pipe testing.
   a. Cleaning and flushing of all process / mechanical piping.
5. Equipment tests.
   a. Factory tests.
   b. Field functional, operational, and performance tests.
6. Tanks.
   a. All water-retaining concrete structures shall be tested for water tightness in accordance with ACI 350.1R.
7. Flow meter (installed) calibration / testing.
8. System acceptance testing.
9. Concrete tests.
10. Moisture-density and relative density tests on embankment, fill, and backfill materials.
11. In-place field density test on embankments, fills, and backfill.
12. Other materials and equipment as specified herein.
13. Concrete materials and mix designs.
14. Embankment, fill, and backfill materials, density, optimum moistures and compaction.
15. QC testing of all precast and/or pre-stressed concrete.
16. All other tests and engineering data required for Engineer's review of materials and equipment proposed to be used in the Work.
17. In addition, the following QC tests shall be performed by Contractor:
    a. Holiday testing of pipeline and all other coatings systems applied to surfaces as required by the Engineer.
    b. Slumps, air bucket tests, compression tests and other confirmation tests.
    c. Air testing of field-welded joints for steel pipe or pipe cylinders and fabricated specials.

d. All testing and inspection of welding work including, but not limited to, welding procedure qualifications, welder operator qualifications, all work performed by the certified welding inspector, all appropriate nondestructive testing of welds and all repair and retest of weld defects.

18. Testing, including sampling, shall be performed by the Contractor's testing firm's laboratory personnel, in general manner and frequency indicated in the Specifications. The Engineer and/or the Owner's representative shall have the right to stipulate the location of the confirmation tests. The Contractor shall provide preliminary representative samples of materials to be tested to laboratory, in required quantities.

19. The testing firm's laboratory shall perform all laboratory tests within a reasonable time consistent with the specified standards and will furnish a written report of each test.

20. The Contractor shall furnish all sample materials and cooperate in the testing activities, including sampling. The Contractor shall interrupt the Work when necessary to allow testing, including sampling to be performed. The Contractor shall have no claim for an increase in Contract Price or Contract Times due to such interruption. The Contractor shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.

21. When testing activities, including sampling are performed in the field by the testing firm's laboratory personnel, the Contractor shall furnish required labor and facilities.
    a. To provide access to Work to be tested.
    b. To obtain and handle samples at the site of the Work.
    c. To facilitate inspections and tests.
    d. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.

22. Where such inspection and testing are to be conducted by an independent laboratory agency, the sample or samples shall be selected by such laboratory or agency or the Engineer and shipped to the laboratory by the Contractor at Contractor's expense.

23. The Contractor shall notify the testing laboratory sufficiently in advance of operation to allow for the assignment of personnel and schedules of tests.

24. The Contractor shall be responsible for furnishing all materials necessary for testing.

G. Transmittal of Test Reports: Written reports of tests and engineering data furnished by the Contractor for the Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings. Final transmittal of all Project testing records shall be required as a final close-out submittal for the release of retainage.

1. The Contractor shall promptly process and distribute all required copies of test reports and related instructions to ensure all necessary retesting or replacement of materials with the least possible delay in progress of the Work.

H. The Contractor shall provide copies of all correspondence between the Contractor and testing agencies to the Engineer.

I. Inspections and tests required by codes or ordinances or by a plan approval authority, and made by a legally constituted authority, shall be the responsibility of and shall be paid for by the Contractor, unless otherwise provided in the Agreement Documents.

J. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

K. Schedules For Testing

1. Establishing Schedule
   a. The Contractor shall, by advance discussion with the testing laboratory determine the time required for the laboratory to perform its tests and to issue each of its findings, and make all arrangements for the testing laboratory to be on site to provide the required testing.
   b. The Contractor shall provide for all required time within the construction schedule.
   c. When changes of construction schedule are necessary during construction, the Contractor shall coordinate all such changes of schedule with the testing laboratory as required.

END OF SECTION 01400

SECTION 01410
TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.01 SCOPE

A. From time to time during progress of the Work, the Engineer may require that testing be performed to determine that materials provided for the Work meet the specified requirements, in accordance with the requirements of the Specifications. Such testing includes, but is not necessarily limited to:

1. Soil.
2. Groundwater.
3. Cement.
4. Aggregate.
5. Concrete.
6. Concrete block.
7. Pipe.
8. Steel and metals.
9. Welding.
10. Soil compaction.
11. Bituminous pavement.

B. Requirements for testing may be described in various sections of these Specifications; where no testing requirements are described but the Engineer decides that testing is required to demonstrate compliance with specified material or performance standards, the Engineer may require such testing to be performed under current pertinent standards for testing.

C. Employment of a testing laboratory shall in no way relieve the Contractor of Contractor's obligation to perform work meeting the requirements of the Contract.

D. The independent testing laboratory shall be selected and paid by the Contractor. The testing laboratory must be approved in writing by the Engineer before any testing services are performed.

E. The Contractor shall pay directly for the services of the independent testing laboratory, approved by the Engineer, for all testing required under this Contract.

1.02 LABORATORY DUTIES

A. Cooperate with Engineer and Contractor.

B. Provide qualified personnel promptly on notice.

C. Perform specified inspections, sampling and testing of materials and methods of construction.

1. Comply with specified standards, ASTM, other recognized authorities and as specified.
2. Ascertain compliance with requirements of Agreement Documents.

D. Promptly notify Engineer and Contractor of irregularity or deficiency of work, which are observed during performance of services.

E. Promptly submit three (3) copies (two (2) copies to the Engineer and one (1) copy to the Contractor) of report of inspections and tests in addition to those additional copies required by the Contractor including:

1. Date issued.
2. Project title and number.
3. Testing laboratory name and address.
4. Name and signature of inspector.
5. Date of inspection or sampling.
6. Record of temperature and weather.
7. Date of test.
8. Identification of product and Specification section.
9. Location of Project.
10. Type of inspection or test.
11. Results of test.
12. Observations regarding compliance with Agreement Documents.

F. Perform additional services as required.

G. Laboratory is not authorized to:

1. Release, revoke, alter, or enlarge on requirements of Agreement Documents.
2. Approve or accept any portion of Work.

1.03 CONTRACTOR RESPONSIBILITIES

A. Cooperate with laboratory personnel; provide access to Work and/or manufacturer's requirements.

B. Provide to laboratory, preliminary representative samples, in required quantities, of materials to be tested.

C. Furnish copies of mill test reports.

D. Furnish required labor and facilities.

1. To provide access to Work to be tested.
2. To obtain and handle samples at the site.
3. To facilitate inspections and tests.

4. Build or furnish a holding box for concrete cylinders or other samples as required by the laboratory.

E. Notify the testing laboratory sufficiently in advance of operation to allow for the assignment of personnel and schedules of tests.

F. Laboratory Tests: Where such inspection and testing are to be conducted by an independent laboratory agency, the sample or samples shall be selected by such laboratory or agency or the Engineer and shipped to the testing laboratory by the Contractor at Contractor's expense.

G. Copies of all correspondence between the Contractor and testing laboratory shall be provided to the Engineer.

1.04 QUALITY ASSURANCE

A. Testing, when required, will be in accordance with all pertinent codes and regulations and with procedures and requirements of the American Society for Testing and Materials (ASTM).

1.05 PRODUCT HANDLING

A. The Contractor shall promptly process and distribute all required copies of test reports and related instructions to ensure all necessary retesting or replacement of materials with the least possible delay in progress of the Work.

1.06 FURNISHING MATERIALS

A. The Contractor shall be responsible for furnishing all materials necessary for testing.

1.07 CODE COMPLIANCE TESTING

A. Inspections and tests required by codes or ordinances or by a plan approval authority, and made by a legally constituted authority, shall be the responsibility of and shall be paid for by the Contractor, unless otherwise provided in the Agreement Documents.

1.08 CONTRACTOR'S CONVENIENCE TESTING

A. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

1.09 SCHEDULES FOR TESTING

A. Establishing Schedule

1. The Contractor shall, by advance discussion with the testing laboratory, determine the time required for the laboratory to perform its tests and to issue each of its findings, and make all arrangements for the testing laboratory to be at the site of the Work to provide the required testing.
2. Provide all required time within the construction schedule.

B. When changes of construction schedule are necessary during construction, the Contractor shall coordinate all such changes of schedule with the testing laboratory as required.

1.10 TEST AND CERTIFICATIONS

A. General: As a minimum, the following tests shall be performed and the following certifications provided:

1. Cement: Certified test results by cement manufacturer or by independent laboratory shall be furnished as required by the Engineer.
2. Aggregate and Mortar Sand: Certified test results by aggregate producer or by independent laboratory shall be furnished as required by the Engineer.

B. Soil: The material testing for the soil shall be performed by an independent laboratory as deemed necessary by the Engineer.

C. Groundwater: The material testing for the groundwater shall be performed by an independent laboratory as deemed necessary by the Engineer.

D. Concrete: The material testing for the concrete shall be performed by an independent laboratory as deemed necessary by the Engineer.

E. Steel and Miscellaneous Metal: Reinforcing steel, structural steel and miscellaneous metal may be inspected visually on the site by the Engineer.

F. Compaction of Earthwork

1. The compaction shall be tested by the Engineer or by an independent testing laboratory.
2. The testing shall be performed in a manner in accordance with these Specifications.

G. Bituminous Concrete: The material testing for the bituminous concrete shall be performed by an independent laboratory as deemed necessary by the Engineer.

1.11 TAKING SPECIMENS

A. Unless otherwise provided in the Agreement Documents, all specimens and samples for tests will be taken by the testing laboratory or the Engineer.

1.12 TRANSPORTING SAMPLES

A. The Contractor shall be responsible for transporting all samples, except those taken by testing laboratory personnel, to the testing laboratory.

END OF SECTION 01410

SECTION 01500
TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SCOPE

A. The work covered under this Section includes furnishing all labor, equipment, and materials required to furnish and install temporary facilities and accessories, as shown on the Drawings and specified herein. The Contractor shall provide all temporary facilities necessary for the proper completion of the Work, as necessary and as specified.

B. The Contractor shall maintain temporary facilities in proper and safe condition through the progress of the Work. In the event of loss or damage, the Contractor shall immediately make all repairs and replacements necessary subject to approval of the Engineer and at no additional cost to the Owner. At completion of the Work, remove all such temporary facilities or as directed by the Engineer.

C. All of the office furnishings and equipment provided by the Contractor for the Engineer's facilities under this Section shall remain as property of the Owner.

D. All expenditures for furnishing, installation, maintenance, and recurring costs of temporary facilities, office furnishings, office electrical equipment, various hardware and software, lines, line extensions, and installation of utility service shall be paid by the Contractor and included in Item No. 1 of the Base Bid.

1.02 REQUIREMENTS

A. General

1. The materials, equipment, and furnishings provided under this Section shall be new, and shall meet all the applicable codes and regulations.
2. The Contractor shall make all provisions, and pay all costs of furnishing, installation, maintenance, professional services, permit fees, and site work for the temporary facilities.

B. Construction:

1. Temporary buildings shall be structurally sound, weather tight, with floors raised above ground. All mobile/modular buildings shall comply with the GA-DCA/SBCC/ADA requirements, and shall be Williams-Scottsman or equal.
2. Temporary buildings shall have temperature transmission resistance compatible with occupancy and storage requirements.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Construction Facilities Plan for each work site for approval by the Engineer.
2. Shop drawings of all signs prior to their manufacture and erection.

3. Copy of the Contractors proposed wheel washing stations in the event the Engineer determines their deployment is necessary.

1.04 CONTRACTOR'S FACILITIES

A. The Equalization Facility Site shall be the main staging area for the Contractor's operations. Any additional staging that the Contractor may require shall be identified in the Facilities Plan and provided by the Contractor at no additional cost to the Owner. The Facilities Plan shall include narrative of the mobilization, site preparation, and the schedule for each site of the Work.

B. Contractor's Facilities: The Contractor shall submit a plan of the plant layout to the Engineer for approval within fifteen (15) days of the Notice to Proceed. The Contractor's Facilities, for purposes of this Section, is defined to include but not limited to its field offices, first aid station, and storage facilities. Sufficient construction plant shall be provided and maintained at all points where work is in progress to meet adequately the demands of the Work and with ample margin for emergencies or overload.

C. The Facilities shall be of sufficient capacity and reliability to permit a rate of progress, which will insure completion of the Work within the time stipulated in the Contract. Insufficient, inadequate, improper Facilities, or equipment shall be brought to acceptable condition or shall be removed from the site of the Work.

D. The location of stationary and mobile equipment shall be subject to the Engineer's approval.

E. First Aid Stations: The Contractor shall provide a suitable first aid station at each work site. Each station shall be equipped with all facilities and medical supplies necessary to administer emergency first aid treatment. The Contractor shall have standing arrangements for the removal and hospital treatment of any injured person. The information reflecting this arrangement shall be clearly posted for easy visibility. All first aid facilities and emergency ambulance services shall be made available by the Contractor to the Owner's and Engineer's personnel.

F. The Contractor shall be wholly responsible for the security of the site office and storage compound and for all its plant, materials, equipment, and tools at all times.

G. The Contractor shall make all arrangements for all utilities and shall be responsible for maintaining all utilities, including all Engineer's Facility utility services, at no additional cost to the Owner. In areas where connections to local sewer systems are not practical, the Contractor shall install and maintain sewage holding tank systems. These sewer systems must be equipped with a means of monitoring and preventing overflows. The Contractor shall remove the systems at the end of construction at no additional cost to the Owner.

1.05 ENGINEER'S FACILITIES

A. Engineer's Field Office:

1. Within 90 days after receipt of the Notice to Proceed construct, paint, and furnish all materials and equipment and maintain Engineer's Field Office at the Equalization Facility Site as directed by the Engineer.
2. Furnish equipment specified under this article for the exclusive use of Engineer and its representatives.

3. The Contractor shall provide one 60-foot-long double-wide trailer to serve as the Site Office for the Owner's and Engineer's field staff at the location specified under 1.05.A.1. The interior of the trailer shall be divided by partitions with doors and have a minimum of 6 offices, one conference room, copier room, supply room, a men's and women's restroom. Dimensions for all rooms shall be determined by the Engineer. The size and number of storage closets shall be as directed by the Engineer. All closets and partition doors shall be furnished with integral locks

4. The office shall have at least two exterior entries with solid core doors with deadbolts and a covered porch at least 6 feet square at each entrance.

5. The Engineer will indicate the locations of telephone/computer outlets and certain electrical outlets on the modular office shop drawing. However, there shall be a minimum of one-combination telephone/computer outlets per office including, the conference room and all shall be wired to the communication's closet

6. Electrical outlets are to be no more than 6 feet apart, minimum two per wall, and all are to be surge protected type; provide four duplex surge protected outlets at 42 inches AFF in communication closet. Other changes in the desired arrangement will be shown on the shop drawing, also.

7. Provide approximately, 1-foot wide, perforated aluminum soffits on all four sides and a continuous ridge vent.

8. All walls are to be vinyl covered sheetrock (all exterior and all interior walls to be fully insulated).

9. Floors to be double 3/4-inch CDX plywood minimum with vinyl tile floor covering throughout. Color coordinated vinyl base-cove throughout.

10. Provide eighteen 48-inch by 30-inch minimum sliding, lockable, double pane insulated windows with insect screens and metal mini-blinds.

11. Provide 4-foot fluorescent lighting fixtures with diffuser covers to provide 100-foot candles of illumination for each and every area; Provide 18-inch fluorescent lighting fixture in bathrooms.

12. The complete restrooms are to include:
    a. An elongated ceramic commode.
    b. Ceramic urinal (for one restroom only).
    c. Ceramic sink.
    d. Single handle brass/chrome faucet (Delta minimum).
    e. Vinyl coated wire shelf for supplies 12-inch depth by 24-inch width, minimum.
    f. Bobrick No. B-398 stainless steel medicine cabinet with mirror doors.
    g. Bobrick No. B-35903 stainless steel paper towel dispenser.
    h. Bobrick No. B-697 stainless steel toilet paper holder.
    i. 40-gallon hot water heater (to serve both restrooms).
    j. Bobrick No. B-147 stainless steel liquid soap dispenser.

13. Exterior doors to be insulated heavy-duty steel with pneumatic/hydraulic closures and Best lock sets and double cylinder deadbolts. Keyed locksets on all interior doors except restrooms to be privacy type, all to be Kwikset, or equal.

14. Chrome coat hook on the back of all interior doors.

15. Interior doors to be pre-hung solid core wood doors with wood trim, all painted gloss white.
16. Sound attenuation/insulation in all interior walls is required.
17. Janitorial equipment closet with door.
18. Communication equipment closet with door to have painted plywood walls. Up to 24 J-boxes with conduit stubbed to under trailer for use in communication installation including up to 2 wall mounted phone boxes. Stainless steel switch-plate and outlet covers. Master circuit surge protector. Lights and receptacles to be on separate circuits; provide 10 dedicated circuits for computers, copiers, etc. Emergency lights and lighted exit signs.
19. Three 10-pound fire extinguishers mounted at each exit and at break area.
20. High-pressure sodium photocell controlled light at each entrance, and four exterior flood lights to illuminate parking area.
21. Freeze protection system for water piping, black asphalt architectural shingles, 20-year warranty roof, color-coordinated plastic or PVC skirting with access door, porch with landing, steps and full aluminum canopy at each exterior door..
22. Provide 4" black rain gutter system along entire length of both sides of the trailer along with downspouts, and splash blocks.
23. HVAC system to include:
    a. Dual one-ton minimum heat pump units; two-ton minimum total.
    b. No "end pack" units. A factory applied marine coating of all metal parts on the exterior heat pump unit excepting only the compressor fins is required (no field application of this coating is permitted); auxiliary, in duct heat strips as required; piped condensate drains to eliminate surface evaporation including dry well if needed; single programmable thermostat to control both units simultaneously; easily accessible filter locations; individual returns and supplies for all rooms or spaces including hallways.
    c. Locate units at center of each side of building for optimum and equal air distribution.
    d. All HVAC duct is to be insulated and run on the underside of the trailer with vents in each area in the floor strategically located on interior walls, behind doors.
    e. HEPA air filtration system including manufacturer's recommended maintenance.
24. Computer Systems
    a. Local Area Network. Furnish and install CAT-5e cable, terminations, and connectors to connect the Ethernet 10/100 cards on the computer systems, the printer Ethernet card and copier as a local area network. Cable to be professionally and neatly installed inside the walls or under the floor. Furnish the services of a qualified field technician to set up the Windows XP software as a local area network to function as instructed by the Engineer.
    b. Furnish and install four Dell Dimension 9200 with Intel Pentium D Processor 915 (4MB L2 Cache, 2.8 GHz, 800 FSD) or latest equivalent model. Personal Computer Systems, each equipped as follows:
        i) 2GB Display Adapter and internal 500GB hard drive storage.
        ii) Internal Dual Drive 16X CD/DVD Burner (DVD+RW)
        iii) Optical USB support mouse.
        iv) 20" Wide Screen Flat Panel display
        v) Battery Back-up UPS systems by APC Model Back-UPS ES 725 Broadband (BE725BB).

vi) Dell USB Keyboard
vii) Microsoft Office Professional 2010, Small Business+ Access database
viii) 3 Year On-Site Business Standard Plan
ix) Adobe Acrobat Reader 10.0
x) Integrated Intel PRO 10/100 Ethernet Network Card
xi) HP Color Laser Jet 3600n printer (equivalent latest model)

c. Furnish (2 ea) Laptop computers equipped as follows:
i) Operating System: Genuine Windows 7 Pro Professional.
ii) Memory: 2GB DDR2 SDRAM at 667 MHZ, 2 DIMM each
iii) Hard Drive: 250GB Hard Drive
iv) Combo/DVD+RW Drives: 8X CD/DVD Burner/DVD (Blue Ray) Combo Drive
v) Network Card and Modem: Integrated 10/100/1000 Network Card and Modem.
vi) External Keyboard & Mouse: Wireless Optical mouse & Keyboard (Bluetooth)
vii) Port Replicator: D/Dock, Expansion Station.
viii) Additional Battery: 9-cell Lithium Ion Additional Battery (80 WHr).
ix) Multimedia Cable Kit
x) Notebook carrying case (leather)
xi) Provide maintenance service agreements for all hardware for duration of contract.

d. Computer Software, Latest Versions for each computer system.(Note: This software shall be supplied in addition to the software specified in Specification 01350- Project Document Tracking and Control System);
i) Microsoft Windows 7Pro Professional Edition.
ii) Microsoft Office 7Pro, Professional Edition.
iii) Adobe Professional, latest version

25. Wall jacks are to be located as designated by the Engineer.

26. Provide the following furnishings, fixtures, and equipment, as modified and approved by the Engineer, as follows:
a. Seven (7) - 60 x 30-inch desks.
b. Nine (9) - 36 x 12 x 72-inch bookcases.
c. One (1) - 46 x 144-inch conference table.
d. Seven (7) Herman Miller Aeron ® loaded chairs w/Titanium base. (color-carbon).
e. Fourteen (14) - swivel/tilt conference arm chairs approximately twenty-two (22) inches wide.
f. Six (6) - side chairs.
g. Six (6) Fireking 22125, black, 4-drawer, legal locking fireproof file cabinets.
h. Two (2) - metal storage cabinet, 36 x 78 x 18-inch w/ lock.
i. One (1) - drafting table, 37.5 x 72-inch top.
j. Two (2) - drafting stool.
k. One (1) - 1.2 cubic, 900 watt microwave.
l. One (1) - minimum 18 cubic feet refrigerator/freezer with ice maker.
m. Eight (8) - marker board, 4 x 6-feet.
n. One (1) - mobile plan rack w/ 8 clamps.

o. Two (2) - drafting fluorescent light with bulbs.

p. One (1) - water cooler with bottled water, with hot and cold potable water.

q. One (1) double pot coffee machine with water supply connection.

r. One (1) boot scraper with dual brushes for each exterior door.

s. Six (6) Tenex static control chair mats, 46-inch by 60-inch with 33-inch by 10-inch lip, standard weight.

t. Six (6) tall black plastic trash receptacles (Rubbermaid).

27. Provide the following Video/Photo Electronics:
    a. Four (4) Canon Power Shot SD1000 Digital Elph Camera or equivalent current model with 4 GB SD Memory Card, soft carry case, and spare battery.

28. Provide one (1) plain paper copier machine, Konika Minolta, Model DI 5510 or equivalent current model (Owners choice) with automatic document feeder, multisheet and single sheet feeder, 5-1/2 by 8-1/2 to 11 by 17; zoom reduction/enlargement from 64 percent to 156 percent in 1 percent increments; 3 paper supply trays with 250 sheets each (8-1/2 by 11, 8-1/2 by 14, 11 by 17); and with a office finisher with multi-position stapling and optional hole punching. The Contractor shall provide a three-year maintenance service contract and copy paper, toner/ink cartridges, etc., for this machine during the Contract period plus 6 months. Furnish two spare toner/ink cartridges for each machine at all times.

29. The Contractor shall be responsible for all office setup costs including electrical, water, sewer, and telephone installation costs. The Contractor is also responsible for all service and maintenance including cleaning, light bulbs, and HVAC filters, etc. for the City field office.

30. The Contractor shall furnish the services of a professional computer system installer to install, connect, and test the various computers, printers, communication equipment, and other peripherals specified in this Section. The various cable types, lengths, adapters, and other connectors are not listed below and will have to be furnished to conform to the Project office and equipment layout and to complete the installation as a satisfactorily functioning system. In addition, maximum effort shall be made to terminate the various cables in wall mounted outlets with appropriate connectors to reduce cable clutter and achieve an orderly appearance for the installation. The wall outlets are also not listed below. The same professional firm shall provide a full on-site maintenance agreement covering all replacement parts and labor. The Contractor shall provide operational support of the computer network for the duration of the construction Contract.

31. The Contractor shall provide free and clear access for the occupants and visitors for the duration of the Project.

32. The Contractor shall protect all utility lines leading to and from the Project office, including all water, sewer, gas, telephone, and other communication lines.

1.06 TELEPHONE SERVICES

A. General

1. A telephone system to be installed and maintained for the duration of the project.

2. Make all necessary arrangements for outside telephone service to Contractor's office, Engineer's Field Office, and the First Aid Stations. The connection to Engineer's Facilities shall be consistent with the specified hardware requirements for such facilities. Schematic drawings, showing the complete telephone system to be installed, shall be provided for

review by the Engineer before installation of the service. All portions of the communication system shall be maintained in good working condition.

3. All expenditures for installation costs of hardware, lines, line extensions, service changes, and recurring service charges for telephone service shall be paid by the Contractor.

4. The Contractor shall provide the Engineer's Field Office with two (2) dedicated lines, with paging, voice mail, conference calling, speaker phone, redial and speed dialing, call and message waiting signals, volume control, outgoing call restriction, night service, and flexible function keys.

5. One phone sets will be provided in each office, and in the conference room.

6. The Contractor shall furnish two (2) additional dedicated telephone lines to the Engineer's Project Office. At each office, one (1) line will be used for a dedicated facsimile machine. The second line at each office will be used for dedicated computer communications.

7. The Contractor shall furnish one (1) cable modem, ADSL, DSL or ISDN line to the Engineer's Project Office. These lines will be used to access the server for the Primavera Expedition software maintained in the Engineer's Project Office.

1.07 PARKING FACILITIES

A. General: The Contractor shall provide ample parking, either graveled or paved, adjacent to the Engineer's Field Office and without necessitating jockeying of cars, for a minimum of ten (10) cars at the Engineer's Field Office.

B. The parking surfaces shall be promptly and adequately maintained by the Contractor for the duration of the Contract.

1.08 SECURITY AND MAINTENANCE

A. General: The Contractor shall provide periodic indoor and outdoor maintenance and weekly cleaning for the Engineer's Field Office, furnishings, equipment, and services as specified herein above. This shall include maintenance of the grounds, including picking up trash and mowing grass.

B. During other than normal daytime office working hours, the Contractor shall provide a totally separate electronic security system monitored by a security agency for the Engineer's Field Office. All offices shall be equipped with exterior security flood lights automatically activated by darkness and in sufficient number and placement to provide adequate lighting of the office and the parking areas.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PREPARATION

A. The Contractor shall fill and grade sites for temporary structures to provide surface drainage.

3.02 INSTALLATION

A. The Contractor shall construct temporary field offices, first aid stations, and storage facilities on proper foundations and provide connections for all utility services.

B. The Contractor shall locate construction office facilities at locations within the Project approved by the Engineer.

C. The Contractor shall determine the need for temporary utility services, including utility services for the Engineer's facilities and first aid stations, and make all arrangements with utility companies and governmental agencies to secure such services. Such services shall be provided at no additional cost to the Owner. Temporary utility services shall be furnished, installed, connected, and maintained by Contractor in a workmanlike manner, satisfactory to the Engineer, and shall be removed in like manner prior to final acceptance.

D. The Contractor shall provide an outside standpipe equipped with a non-freeze hose bib at each of the Engineer and Inspector's Site Office. The hosebib shall be sized for a standard one-half inch (½") garden hose connection.

3.03 MAINTENANCE AND CLEANING

A. For the duration of the Project, the Contractor shall repair and clean the office, parking area, and access route and provide complete professional janitorial services, including toilet paper and paper towels, liquid soap, air fresheners in the Engineer's Field Office. The Contractor or the janitorial service is to provide floor mats at exterior entrances (inside and outside of door).

B. Cleaning shall be done on a weekly basis, to the satisfaction of the Engineer, during other than normal daytime office working hours. These services shall include sweeping, vacuuming, dusting, emptying of trash, cleaning and sanitizing of wash basins, bathroom and shower facility, mopping, and monthly waxing of all vinyl floors. Trash containers shall be lined with trash bags.

C. The Contractor shall provide for monthly exterminating services of the office.

3.04 REMOVAL

A. The Contractor shall remove temporary field offices, contents, and discontinue services at a time when no longer needed as agreed to in writing by the Engineer. The office furnishings and equipment shall be packed, moved, and unpacked by the Contractor to a location designated by the Owner.

B. The Contractor shall remove foundations and debris; grade site to required elevations; clean, and restore areas to Engineer's satisfaction.

END OF SECTION 01500

SECTION 01540
SECURITY AND SAFETY

PART 1 - GENERAL

1.01 SECURITY PROGRAM

A. The Contractor shall protect the Work, including all field office trailers and their contents from theft, vandalism, and unauthorized entry.

B. The Contractor shall initiate a site security program at the time of mobilization onto the site of the Work, which provides adequate security for site stored and installed material.

C. The Contractor shall maintain the security program throughout the duration of the Contract.

D. The Contractor is wholly responsible for the security of their storage compound and laydown areas, and for all their plant, material, equipment, and tools at all times.

E. The Contractor shall provide the Engineer with a list of twenty-four (24) hour emergency phone numbers including chain of command.

1.02 ENTRY CONTROL

A. The Contractor shall restrict entry of unauthorized personnel and vehicles onto the site of the Work.

B. The Contractor shall allow entry only to authorized persons with proper identification.

C. The Contractor shall maintain an Employee Log and Visitor Log and make the logs available to the Owner upon request. These logs shall be submitted to the Engineer bi-weekly or as requested.

D. The Contractor shall require all visitors to sign the Visitor Acknowledgment of the Program Site Rules/Visitor Log, which includes a release form. Copies of these forms shall be submitted to the Engineer bi-weekly and maintained in the Contractor's security files on-site.

E. The Contractor shall require all employees to sign the Employee Acknowledgment of Project Site Rules Log included at the end of this Section. All Contractor and sub-contractor employees shall receive a new employee orientation. Signing the Employee Log by the employee is certifying that the orientation training has been received.

F. The Engineer has the right to refuse access to the site of the Work or request that a person or vehicle be removed from the site of the Work, if found violating any of the Project safety and security conduct rules.

1.03 BARRICADES, LIGHTS AND SIGNALS

A. The Contractor shall furnish and erect such barricades, fences, lights and danger signals and shall provide such other precautionary measures for the protection of persons or property and of the work as necessary. Barricades shall be painted in a color that will be visible at night. From sunset to sunrise, the Contractor shall furnish and maintain at least one (1) light at each barricade

and sufficient numbers of barricades shall be erected to keep vehicles from being driven on or into any work under construction.

B. The Contractor shall be held responsible for all damage to the Work and any resulting injuries due to failure of barricades, signs, and lights and whenever evidence is found of such damage, the Contractor shall immediately remove the damaged portion and replace it at Contractor's cost and expense. The Contractor's responsibility for the maintenance of barricades, signs, and lights shall not cease until the Project has been accepted by the Owner.

1.04 RESTRICTIONS

A. The Contractor shall not allow cameras on site or photographs taken except with approval of the Owner or the Engineer.

1.05 CONTRACTOR SAFETY/HEALTH AND SECURITY PLAN

A. Prior to the performance of any work the Contractor shall prepare a contract specific Safety/Health and Security Plan signed by an officer of the Contractor's organization. Adequacy of the Safety/Health and Security Plan is the responsibility of the Contractor.

B. The Engineer will not review the Contractor's safety plan for the adequacy of the plan. The plan shall:

1. Identify the person(s) responsible for implementation and enforcement of Safety/Health and Security rules and regulations for this Project.
2. Generally address safe work procedures for the activities within the Contractor's scope of work.
3. Include a new employee orientation program, which addresses job and site specific rules, regulations, and hazards.
4. Include the Contractor's Drug Free Work Place Policy including substance abuse prevention and testing program.
5. Include provisions to protect all of the Contractor's employees, and other persons and organizations who may be affected by the work from injury, damage, or loss.
6. Comply with current federal, state and local laws including those promulgated by OSHA; locally accepted safety codes; applicable regulations, standards and practices.
7. Include a site specific emergency action and evacuation plan.
8. Include Hazard Communication/Right To Know Program.
9. Include security procedures for the Contractor's work, tools, and equipment.
10. Include the capability of providing the Engineer with documentation to show compliance with their plan, plus accidents and investigation reports.
11. Address any other Contract Specific requirement, including the Unique Requirements of these specifications.

C. Provide a Job Safety Analysis (JSA) for the scope of work, prior to the start of Work.

D. Review of the Contractor's Safety Plan by the Engineer shall not impose any duty or responsibility upon the Engineer for the Contractor's performance of the Work in a safe manner.

E. The Contractor shall be fully responsible for the safety and health of its employees, its subcontractors, Engineer's employees, Owner's employees, and any other personnel at the site of the Work.

F. The Contractor shall provide the Engineer with all safety reports, training records, competent persons list, and accident reports prepared in compliance with Fed/OSHA and the Project Safety/Health and Security Plan.

1.06 PROJECT SAFETY COORDINATOR

A. The Contractor shall be responsible for the safety of the Contractor's and Engineer's employees, the Owner's personnel and all other personnel at the site of the Work. The Contractor shall identify a Project Safety Coordinator, as required under GC-18, Paragraph F., on the job with an appropriate office on the job site to maintain and keep available safety records and up-to-date copies of all pertinent safety rules and regulations.

B. The Project Safety Coordinator shall:

1. Ensure compliance with all applicable health and safety requirements of all entities having jurisdiction.
2. Schedule and conduct safety meetings and safety training programs as required by law for all personnel engaged in the Work.
3. Post all appropriate notices regarding safety and health regulations at locations that afford maximum exposure to all personnel at the site of the Work.
4. Post the name, address, and hours of the nearest medical doctor; names and addresses of nearby clinics and hospitals; and the telephone numbers of the fire and police departments.
5. Post appropriate instructions and warning signs with regard to all hazardous areas or conditions.
6. Have proper safety and rescue equipment adequately maintained and readily available for any contingency. This equipment shall include such applicable items as: proper fire extinguishers, first aid kits, safety ropes and harnesses, stretcher, life savers, breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, explosion meters, and any other equipment mandated by law.
7. Make inspections at least once daily in accordance with an inspection checklist report form to ensure that all machines, tools, and equipment are in safe operating condition; that all work methods are not dangerous; and that all work methods are free of hazards.
8. Submit to the Engineer upon request, copies of all inspection checklist report forms, safety records, and all safety inspection reports and certifications from regulating agencies and insurance companies.
9. Notify the Engineer of a serious accident immediately, followed by a detailed written report within twenty-four (24) hours. "Serious accident" is defined as that requiring an absence of work of more than two (2) days and/or hospitalization.
10. Notify the Engineer immediately in the event of a fatal accident.

11. Notify Engineer of any accident claim against the Contractor or any sub-contractor immediately, followed up by a detailed written report on the claim and its resolution.

12. Review safety aspects of the Contractor's submittals as applicable.

1.07 HEALTH AND SAFETY PERSONNEL

A. The Contractor shall provide Health and Safety personnel to monitor worker safety including but not limited to the removal of contaminated soil. The qualifications of such personnel shall be submitted to the City for approval prior to assignment to the Work.

VISITOR ACKNOWLEDGMENT OF THE PROJECT SITE RULES

By Signing this Visitor's Log, I acknowledge that I have read, understand and agree to abide by the project rules outlined below.

In consideration of my receipt of a visitor's pass as issued by the Engineer directly or indirectly for the Owner of Atlanta, I waive on behalf of myself, my heirs, employer, legal representatives, and assigns and hereby release and discharge the Owner, the Engineer, the Designer, and their subcontractors and consultants and each of their directors, officers, employees, representatives, and agents from any and all claims, actions, causes of action or any charge of any kind whatsoever which may arise or could arise in the future as a result of my being present at the facility including injury, death or property damage whether or not caused by the fault or negligence of any of the parties released hereunder.

I further acknowledge that I have been briefed on specific hazards, hazardous substances that are on the site of the Work and the site emergency action procedure.

PROHIBITED ACTIVITIES

- Unauthorized removal or theft of City's property.
- Violation of safety and security rules or procedures.
- Possession of firearms or lethal weapons on the site of the Work.
- Acts of sabotage.
- Destruction or defacing City's property.
- Failure to use sanitary facilities.
- Failure to report accidents or job related injuries.
- Being under the apparent influence of drugs, alcohol or other intoxicants or in possession of drugs, alcohol or other intoxicants on the property.
- Wearing shorts or tennis shoes on the site of the Work.
- Failure to wear a hardhat/safety glasses.
- Gambling at any time on the site of the Work.
- Fighting, threatening behavior, or engaging in horseplay on the project.
- Smoking in unauthorized areas on the project.
- Open fire cooking or making unauthorized fires on project property.
- Selling items or raffles without authorization.
- Use of unauthorized cameras on the project.
- Use of radio or television in the construction area.
- Failure to park personal vehicle in authorized parking area.
- Failure to wear designated identification [Site Specific].
- Failure to use designated gates.

I have read, understand, and agree to abide by the PROJECT SITE RULES. Furthermore, I understand that failure to abide by these rules is grounds for being denied access to the site of the Work. I have received a personal copy for my use and reference.

VISITOR LOG

BY SIGNING THIS LOG I ACKNOWLEDGE THAT I HAVE READ, UNDERSTAND, AND AGREE TO ABIDE BY THE PROJECT RULES OUTLINED ABOVE. THIS IS NOT A VEHICLE ACCESS PERMIT.

VISITOR'S NAME PRINT	SIGNATURE	COMPANY VISITED	DATE	IN	OUT

EMPLOYEE ACKNOWLEDGMENT OF THE PROJECT SITE RULES

By Signing this Employee Log, I acknowledge that I have read, understand, and agree to abide by the project rules outlined below.

PROHIBITED ACTIVITIES

- Unauthorized removal or theft of City's property.
- Violation of safety or security rules or procedures.
- Possession of firearms or lethal weapons on site of the Work.
- Acts of sabotage.
- Destruction or defacing City's property.
- Failure to use sanitary facilities.
- Failure to report accidents or job related injuries.
- Under the apparent influence of drugs, alcohol or other intoxicants or in possession of drugs, alcohol or other intoxicants on the property.
- Wearing shorts or tennis shoes at the site of the Work.
- Failure to wear a hardhat.
- Gambling at any time at the site of the Work.
- Fighting, threatening behavior, or engaging in horseplay on the site of the Work.
- Smoking in unauthorized areas on the project.
- Open fire cooking or making unauthorized fires on site of the Work.
- Selling items or raffles without authorization.
- Use of unauthorized cameras on the project.
- Use of radio or television in the construction area.
- Failure to park personal vehicle in authorized parking area.
- Failure to wear designated identification [Site Specific].
- Failure to use designated gates.

I have read, understand, and agree to abide by the PROJECT SITE RULES. Furthermore, I understand that failure to abide by these rules is grounds for being denied access to the project site. I have received a personal copy for my use and reference.

EMPLOYEE LOG

BY SIGNING THIS LOG ACKNOWLEDGMENT I HAVE READ, UNDERSTAND, AND AGREE TO ABIDE BY THE PROJECT RULES OUTLINED ABOVE AND ALL STATE, FEDERAL, LOCAL OR ANY OTHER CONTRACT OBLIGATIONS THAT MAY APPLY. I FURTHER ACKNOWLEDGE THAT I HAVE BEEN ORIENTATED AS TO THE SITE SPECIFIC HAZARDS, ANY HAZARDOUS SUBSTANCES I MAY BE EXPOSED TO WHILE ON THE SITE AND THE SITE/COMPANY EMERGENCY ACTION PROCEDURES, BY A REPRESENTATIVE OF THE COMPANY.

EMPLOYEES (PRINT)	SIGNATURE	COMPANY NAME	DATE
Signature of Company Representative		Date Signed	

END OF SECTION 01540

SECTION 01600
GENERAL MATERIAL AND EQUIPMENT REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. All installed materials and equipment are to be the latest version of the manufacturer's product line and not be outdated by newer versions at the time of purchasing. Materials and equipment, which show any signs of extended storage such as corrosion, scratches, and dents will not be accepted for installation in this project.

B. All equipment used for performing the Work shall conform to the latest version of all applicable safety standards including, but not limited to, OSHA requirements. The Contractor shall not exceed or ignore any requirements or recommendations of the equipment manufacturer. Equipment not meeting requirements of this Section will be barred from use on the project.

C. All installed material and equipment shall meet or exceed the latest applicable code requirements including, but not limited to; Underwriters Laboratory, Standard Building Code, and OSHA, as well as requirements of these Specifications. Where there is conflict with requirements of the Contract Documents and code requirements, comply with the more stringent requirements with no additional compensation to the Contractor.

PART 2 - MATERIALS AND EQUIPMENT

2.01 ANCHOR BOLTS

A. All anchor bolts to be ANSI type 316 stainless steel unless otherwise specified or indicated, and must conform to requirements of this Section and the material articles in the appropriate Sections they are used.

B. All anchor bolts are to be supplied by the manufacturer or fabricator of the specific material or equipment to be installed.

C. Design Criteria for Anchor Bolts:

1. When the size, length, or load carrying capacity of an anchor bolt, expansion anchor, or concrete insert is not shown on the Drawings, provide the size, length, and capacity required to carry the design load times a minimum safety factor of four.
2. Determine design loads as follows:
   a. For equipment anchors, use the design load recommended by the manufacturer and approved by the Engineer.
   b. For pipe hangers and supports, use one half the total weight of pipe, fittings, valves, accessories, and water contained in pipe, between the hanger or support in question and adjacent hangers and supports on both sides.
3. Allowances for vibration are included in the safety factor specified above.
4. Anchors shall develop ultimate shear and pull-out loads of not less than the following values in concrete:

Bolt Diameter (Inches)	Min. Shear (Pounds)	Min. Pull-Out Load (Pounds)
½	4,500	6,300
⅝	6,900	7,700
¾	10,500	9,900

5. Embedment depth to be 6 inches for epoxy anchors and 4 inches for steel expansion anchors, unless noted otherwise on the drawings.

D. Anchor Type and Manufacturer

1. Where epoxy anchors are noted on the drawings, provide ANSI type 316 stainless steel threaded rod with Speed Bond #1 epoxy injection as manufactured by Prime Resins, Inc. or equal.
2. For all other applications, provide ANSI type 316 steel expansion anchors from one of the following manufacturers.
   a. Hilti, Incorporated.
   b. Ramset, Incorporated.
   c. or equal.
3. Install anchors per manufacturer's recommendations and this Section.
   a. Drilled anchorage holes are to be blown out with compressed air before installing anchor.

2.02 CONNECTION BOLTS

A. Materials shall be as specified in other Sections of the Specifications, or as shown on the Drawings. Where materials are not specified or shown on the Drawings, they shall be of ANSI Type 316 stainless steel, with ANSI Type 316 stainless steel nuts and washers.

B. Unless otherwise specified, stud, tap, and machine bolts and nuts shall be ANSI Type 316 stainless steel and shall conform to the requirements of ASTM Standard Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners, Designation A307-80. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to ANSI Standard B1.1-1974 for Unified Inch Screw Threads (UN and UNR Thread Form).

2.03 CONCRETE INSERTS

A. Concrete inserts for hangers shall be designed to support safely, in the concrete that is used, the maximum load that can be imposed by the hangers used in the inserts. Inserts for hangers shall be of a type, which will permit adjustment of the hangers both horizontally (in one plane) and vertically and locking of the hanger head or nut. All inserts shall be galvanized, then epoxy phenolic primed and top coated with PVC, using thermal bond process.

2.04 SLEEVES

A. Unless otherwise indicated on the Drawings or specified, openings for the passage of pipes through floors and walls shall be formed of sleeves of standard-weight, stainless-steel pipe. The sleeves shall be of ample diameter to pass the pipe and its insulation, if any, and to permit such expansion as may occur. Sleeves shall be of sufficient length to be flush at the walls and the bottom of slabs and to project 4-in. above the finished floor surface. Threaded nipples shall not be used as sleeves.

B. Sleeves in exterior walls below grade or in walls to have liquids on one or both sides shall be as detailed on the Drawings and specified in other Sections.

C. All sleeves shall be set accurately before the concrete is placed or shall be built in accurately as the masonry is being built.

2.05 ELECTRICAL EQUIPMENT ENCLOSURES

A. All items of electrical equipment that are furnished with process equipment shall conform to the requirements specified under the appropriate electrical sections of the specifications. Enclosures for electrical equipment such as switches, starters, etc., shall conform to the requirements specified under the appropriate electrical sections of the specifications.

2.06 EQUIPMENT DRIVE GUARDS

A. All equipment driven by open shafts, belts, chains, or gears shall be provided with acceptable all-metal guards enclosing the drive mechanism. Guards shall be constructed of epoxy paint coated, galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members. Guards shall be secured in position by steel braces or straps, which will permit easy removal for servicing the equipment. The guards shall conform in all respects to all applicable safety codes and regulations.

2.07 NAMEPLATES

A. With the exception of the items mentioned below, each piece of equipment shall be provided with a substantial nameplate of non-corrodible metal, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate.

B. This requirement shall not apply to standard, manually operated gate, lobe, check and plug valves.

C. Each process valve shall be provided with a substantial tag of non-corrodible metal securely fastened in place and inscribed with an identification number in conformance with the tag numbers indicated on the Process and Instrumentation Drawings.

2.08 LUBRICANTS

A. During testing and prior to acceptance, the Contractor shall furnish all lubricants necessary for the proper lubrication of all equipment furnished under this contract.

2.09 PROTECTION AGAINST ELECTROLYSIS

A. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

2.10 TRANSPORTATION, HANDLING, STORAGE AND PROTECTION

A. Packing and Shipping:

1. Product and materials shall be shipped and handled in ways which will prevent damage.
2. Equipment shall be protected against damage from moisture, dust, handling, or other cause during transport from manufacturer's premises to the site of the Work. Bearing housing, vents, and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.
3. Ship equipment, material, and spare parts in assembled units except where partial disassembly is required by transportation regulations or for protection of components.
4. Pipe and appurtenances shall be handled, stored, and installed as recommended by the manufacturer. Pipes shipped with interior bracing shall have the bracing removed only when recommended by the pipe manufacturer.
5. Stiffeners shall be used where necessary to maintain shapes and to give rigidity.
6. Each item or package shall be marked with the number unique to the specification reference covering the item. Spare parts shall be packed in containers bearing labels clearly designating contents and pieces of equipment for which intended.

B. Acceptance at Site:

1. Damaged items will not be permitted as part of the Work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Engineer.
2. Damage shall be corrected to conform to the requirements of the Contract before the assembly is incorporated into the Work.
3. The Contractor shall bear the costs arising out of dismantling, inspection, repair, and reassembly.

C. Storage and Protection:

1. During the interval between the delivery to the site and installation, equipment, and materials shall be stored in an enclosed space affording protection from weather, dust, and mechanical damage and providing favorable temperature, humidity, and ventilation conditions to ensure against equipment deterioration. Equipment shall be stored at an elevation higher than the 100 year flood plain. Manufacturer's recommendations shall be adhered to in addition to these requirements.
2. Equipment and materials to be located outdoors may be stored outdoors if protected against moisture condensation. Equipment shall be stored at least 6 inches above the ground at an elevation higher than the 100 year flood plain. Temporary power shall be provided to

energize space heaters or other heat sources for control of moisture condensation. Space heaters or other heat sources shall be energized without disturbing the sealed enclosure.

2.11 UNIT RESPONSIBILITY

A. Equipment systems made up of two or more components shall be provided as a unit by the responsible manufacturer. Unless otherwise specified, the Contractor shall obtain each system from the supplier of the driven equipment, which supplier shall provide all components of the system to enhance compatibility, ease of construction, and efficient maintenance. The Contractor shall be responsible to the Owner for performance of all systems in accordance with the provisions of the General Conditions of the Contract Documents.

B. Where the detailed specifications require the Contractor to furnish a certificate of unit responsibility, such certificate shall be executed by the manufacturer. No other submittal material shall be processed until the Certificate of Unit Responsibility has been received and has been found to be satisfactory. A typical Manufacturer's Certificate of Unit Responsibility form is included in this specification.

2.12 SERVICES OF MANUFACTURER'S REPRESENTATIVE

A. Where manufacturers' services are specified, the Contractor shall furnish a qualified representative of the manufacturer to provide these services. Where time is necessary in excess of that stated in the Specifications for the manufacturers' service representative to complete the specified services, the additional time required to perform the services shall be considered incidental work for which the Contractor will receive no additional compensation.

B. After installation of the listed equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the manufacturers' representative shall inspect, operate, test and adjust the equipment. The inspection shall include, but shall not be limited to, the following points as applicable:

1. Soundness (without cracked or otherwise damaged parts).
2. Completeness in all details, as specified.
3. Correctness of setting, alignment, and relative arrangement of various parts.
4. Adequacy and correctness of packing, sealing and lubricants.

C. The operation, testing and adjustment shall be as required to prove that the equipment is left in proper condition for satisfactory operation under the conditions specified.

D. On completion of its work, the manufacturer's or supplier's representative shall submit in triplicate to the Engineer Certificate Submittals in accordance with sub-paragraph M of this paragraph and a complete signed report of the result of his inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a certificate that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

E. After the Engineer has reviewed the reports from the manufacturers' representative, the Contractor shall make arrangements to have the manufacturers' representatives present when the field acceptance tests are made.

F. Requirements of this paragraph will be in addition to those of appropriate equipment and material Sections.

G. Definitions

1. For purposes of furnishing manufacturers' services, refer to Section 01664-Training, and the following definitions shall apply:
   a. Manufacturer's Representative: Employee of manufacturer who is factory trained and knowledgeable in technical aspects of their products and systems.
   b. Construction Period: The time period from the Contractor's purchase order date to the date of certification by the manufacturer that the material or equipment is properly installed and that functional and performance tests, as applicable to the equipment specified, have been successfully demonstrated.
   c. Man-Day: One man for 8 hours straight time, exclusive of Saturdays, Sundays, or holidays.

H. Fulfillment of Specified Minimum Services

1. Only those manufacturers' services, including trips to the jobsite or training classroom, receiving prior written acceptance or authorization by the Engineer shall act to fulfill the specified services.
2. If manufacturer's representative is found deficient in training or experience by the Engineer, furnish other acceptable representatives after acceptance of resumes and other documentation of proposed representatives.

I. Proper Installation of Products and Systems

1. Furnish manufacturers' representatives of products and systems. Representatives shall resolve assembly or installation problems attributable to, or associated with, their products and systems, whether or not specifically required in the Specifications.

J. Functional Testing

1. Where functional (or run) testing is required in the Specifications, furnish manufacturer's representative to assist with the test. This shall include checking for proper rotation, alignment, speed, excessive vibration, and quiet operation. Perform initial equipment and system adjustment and calibrations in the presence and with the assistance of the manufacturer's representative.
2. Obtain manufacturer's review and acceptance of Contractor's certification of functional testing, where such certification is specified.

K. Performance Testing

1. Where performance testing is specified, furnish manufacturer's representative to assist the test as specified for the particular equipment, and to correct malfunction of equipment. Follow specified test procedures.

2. These services shall continue until:
   a. Equipment or systems have been successfully tested for performance.
   b. Performance test report has been reviewed and accepted.
   c. Equipment or systems have been accepted by Engineer for startup.
3. Unless otherwise specified, performance testing shall use plant fluid or material that the equipment or system is designed to handle during normal service conditions.

L. Training of Owner's Personnel

1. Contractor's Personnel: Designate and provide the Contractor's personnel to be responsible for coordinating and expediting training duties. The person(s) shall be present during training coordination meetings with the Engineer and shall be familiar with the Operation and Maintenance (O & M) Manual information specified in the General Conditions of the Contract Documents.
2. Manufacturer's Representative: Where training of Owner's personnel is required in the Specifications, furnish manufacturer's representative to provide detailed instructions to Owner's personnel for operation and maintenance of the specified equipment.
   a. Training services include pre-startup classroom instruction, post-startup classroom instruction, and onsite equipment instruction, as stated in the Specifications.
   b. Manufacturer's representative shall be familiar with plant O & M requirements as well as with the specified equipment.
3. Pre-startup Training: Coordinate pre-startup training periods with Owner's operating personnel and manufacturers' representatives, and with submittal of O & M Manuals.
   a. Pre-startup training shall be completed at least fourteen (14) days prior to actual startup.
   b. O & M Manuals shall be reviewed, accepted, and resubmitted, in accordance with GC-28, before startup.
4. Post-Startup Training: Where post-startup training is required in the Specifications, furnish and coordinate the specified manufacturers' services and Contractor's personnel for post-startup training of Owner's operating personnel.

M. Certificate Submittals

1. The forms included with this Section are to be used by the Contractor and by manufacturers of systems and products to certify proper installation, completion of functional testing, and performance testing results.

MANUFACTURER'S CERTIFICATE
OF
PROPER INSTALLATION

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To verify installation recommendations and warranty is valid.

At a minimum, the following items (if applicable) must be checked:

	Yes	No	NA
Equipment serviced with proper lubricants.			
All safety equipment properly installed.			
Proper electrical connections.			
Proper mechanical connections.			
Equipment meets all warranty requirements.			

List additional items checked: (See Detailed Specification Section)

_____
_____
_____
_____

Comments: _____
_____
_____

(List and attach additional pages, if necessary.)
Signatures (Do not initial.)

Contractor: _____ Date: _____
Manufacturer: _____ Date: _____
Engineer: _____ Date: _____

MANUFACTURER'S CERTIFICATE
OF
FUNCTIONAL TEST ACCEPTANCE INSTALLATION

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To verify installation, that proper adjustments have been made, that the equipment or system is ready for plant startup and operation and warranty is valid.

At a minimum, the following items (if applicable) must be checked:

	Yes	No	NA
Rotation			
Alignment			
Speed			
Noise level			
Initial adjustments			
Initial calibration			

List additional items checked: (See Detailed Specification Section)

_____
_____
_____
_____

Comments: _____
_____
_____

(List and attach additional pages, if necessary.)
Signatures (Do not initial.)

Contractor: _____ Date: _____
Manufacturer: _____ Date: _____
Engineer: _____ Date: _____

MANUFACTURER'S CERTIFICATE
OF
PERFORMANCE TEST ACCEPTANCE

Contractor: _____

Equipment Name: _____

Equipment Tag Number(s): _____

Specification Section: _____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Date: _____ Hours on Site: _____

Purpose: To certify that the equipment or system identified above has been successfully tested for performance and is ready to be accepted by the City for full-time operation.

This certifies that the above equipment or system operated under actual performance conditions, and that the equipment or system meets the specified performance criteria.

Comments: _____
_____
_____
_____

(List and attach additional pages, if necessary.)
Signatures (Do not initial.)

Contractor: _____ Date: _____
Manufacturer: _____ Date: _____
Engineer: _____ Date: _____

CONTRACTOR'S CERTIFICATE
OF
EQUIPMENT START-UP READINESS

Contractor: _____

Equipment Name(s): _____

_____

_____

Equipment Tag Number(s): _____

_____

_____

Specification Section: _____

"I, the undersigned, do hereby certify that all of the necessary hydraulic structures, piping systems, and valves have been successfully tested; that all necessary equipment systems and subsystems have been checked for proper installation, started and successfully tested to indicate that they are all operational; that the systems and subsystems are capable of performing their intended functions; and that the facilities noted above are ready for startup and intended operation."

_____ _____ _____

Signature Title Date

MANUFACTURER'S CERTIFICATE
OF
UNIT RESPONSIBILITY

Manufacturer: _____

Equipment Name: _____

Specification Section(s):_____

Manufacturer/Phone No.: _____

Service Rep./Phone No.: _____

Purpose: To certify that the equipment or system manufacturer identified above accepts unit responsibility for equipment or systems furnished.

This certifies that the above equipment or system manufacturer accepts unit responsibility for equipment or systems furnished under the indicated specification section(s) and that the components furnished are compatible and comprise a functional unit suitable for the specified performance and design requirements.

Signatures (Do not initial.)

Contractor: _____ Date: _____
Manufacturer: _____ Date: _____

END OF SECTION 01600

SECTION 01610
TRANSPORTATION AND HANDLING

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall provide transportation of all equipment, materials and products furnished under these Contract Documents to the site of the Work. In addition, the Contractor shall provide preparation for shipment, loading, unloading, handling, and preparation for installation and all other work and incidental items necessary or convenient to the Contractor for the satisfactory prosecution and completion of the Work.

B. All equipment, materials, and products damaged during transportation or handling shall be repaired or replaced by the Contractor at no additional cost to the City, prior to being incorporated into the Work.

1.02 TRANSPORTATION

A. All equipment shall be suitably boxed, crated, or otherwise protected during transportation.

B. Where equipment will be installed using existing cranes or hoisting equipment, the Contractor shall ensure that the weights of the assembled sections do not exceed the capacity of the cranes or hoisting equipment.

C. Small items and appurtenances such as gauges, valves, switches, instruments, and probes which could be damaged during shipment shall be removed from the equipment prior to shipment, packaged, and shipped separately. All openings shall be plugged or sealed to prevent the entrance of water or dirt.

1.03 HANDLING

A. All equipment, materials, and products shall be carefully handled to prevent damage or excessive deflections during unloading or transportation.

B. Lifting and handling drawings and instructions furnished by the manufacturer or supplier shall be strictly followed. Eyebolts or lifting lugs furnished on the equipment shall be used in handling the equipment. Shafts and operating mechanisms shall not be used as lifting points. Spreader bars or lifting beams shall be used when the distance between lifting points exceeds that permitted by standard industry practice.

C. Under no circumstances shall equipment or products such as pipe, structural steel, castings, reinforcement, lumber, piles, poles, etc., be thrown or rolled off of trucks onto the ground.

D. Slings and chains shall be padded as required to prevent damage to protective coatings and finishes.

END OF SECTION 01610

SECTION 01611
STORAGE AND PROTECTION

PART 1 - GENERAL

1.01 SCOPE

A. The work under this Section includes, but is not necessarily limited to, the furnishing of all labor, tools, and materials necessary to properly store and protect all materials, equipment, products and the like, as necessary for the proper and complete performance of the Work.

B. The Contractor shall store materials, supplies, and equipment at the site of the Work, in such orderly fashion and in such locations as approved by the Engineer that will not unduly interfere with the progress of the Work or the work of any other contractors, or the activities of City personnel.

1.02 STORAGE AND PROTECTION

A. Storage

1. Maintain ample way for foot traffic at all times, except as otherwise approved by the Engineer.
2. All property damaged by reason of storing of material shall be properly replaced at no additional cost to the Owner.
3. Packaged materials shall be delivered in original unopened containers and so stored until ready for use.
4. All materials shall meet the requirements of these Specifications at the time that they are used in the Work.
5. Store products in accordance with manufacturer's instructions.

B. Protection

1. Use all means necessary to protect the materials, equipment and products of every section before, during and after installation and to protect the installed Work and materials of all other trades.
2. All materials shall be delivered, stored, and handled to prevent the inclusion of foreign materials and damage by water, breakage, vandalism, or other causes.
3. Substantially constructed weathertight storage sheds, with raised floors, shall be provided and maintained as may be required to adequately protect those materials and products stored at the site of the Work, which may require protection from damage by the elements.

C. Replacements: In the event of damage, immediately make all repairs and replacements necessary for the approval of the Engineer and at no additional cost to the Owner.

D. Equipment and products stored outdoors shall be supported above the ground on suitable wooden blocks or braces arranged to prevent excessive deflection or bending between supports. Items such as pipe, structural steel, and sheet construction products shall be stored with one end elevated to facilitate drainage.

E. Unless otherwise permitted in writing by the Engineer, building products and materials such as cement, grout, plaster, gypsum board, particleboard, resilient flooring, acoustical tile, paneling, finish lumber, insulation, wiring, etc., shall be stored indoors in a dry location. Building products such as rough lumber, plywood, concrete block, and structural tile may be stored outdoors under a properly secured waterproof covering.

F. Tarps and other coverings shall be supported above the stored equipment or materials on wooden strips to provide ventilation under the cover and minimize condensation. Tarps and covers shall be arranged to prevent ponding of water.

1.03 EXTENDED STORAGE

A. In the event that certain items of major equipment such as air compressors, pumps, and mechanical aerators have to be stored for an extended period of time, the Contractor shall provide satisfactory long-term storage facilities which are acceptable to the Engineer. The Contractor shall provide all special packaging, protective coverings, protective coatings, power, nitrogen purge, desiccants, lubricants, and exercising necessary or recommended by the manufacturer to properly maintain and protect the equipment during the period of extended storage.

END OF SECTION 01611

SECTION 01640
MANUFACTURER SERVICES

PART 1 - GENERAL

1.01 SCOPE

A. The work under this Section defines the minimum scope of services to be provided by the Contractor using factory representatives of the manufacturers of the equipment to be installed during installation, start-up, and operator training.

B. Equipment manufacturers assigned unit responsibility for systems comprised of several components shall provide the services of factory representatives from each component manufacturer to perform the duties required under these Specifications. The equipment manufacturer assigned unit responsibility shall be responsible for coordinating the activities of the system component manufacturers.

1.02 QUALIFICATION

A. Qualification of the representatives for installation, start-up, and operator training purposes shall be appropriate for the equipment being installed and shall be subject to the approval of the Engineer. Where equipment has significant process complexity, furnish the services of engineering personnel knowledgeable in the process involved and the function of the equipment.

B. References in various equipment sections of the terms "factory representative" or "field representative" shall mean an employee of the equipment manufacturer who is completely knowledgeable of the construction, installation, operation, and maintenance of the equipment. A sales representative does not qualify. Any field or factory representative not an active employee of the manufacturer must provide documentation from the manufacturer stating that the individual, by name, has been formally trained in the installation, operation, and maintenance of the equipment and is authorized to make the required certification to perform the required services.

1.03 COORDINATION

A. The Contractor shall coordinate the visits of factory representatives during installation, start-up and operator training in accordance with the requirements of Section 01650-Facility Start-Up of these Specifications.

B. The Contractor shall notify the Engineer seventy-two (72) hours prior to any impending visit by factory representatives so that the Engineer can be present.

C. The Contractor shall coordinate the visits of all factory representatives for operator training with the Owner. The Contractor shall provide the Engineer and the Owner with a training schedule a minimum of thirty (30) days prior to the start of the training period.

D. When approved by the Engineer, the period of service on more than one item furnished by the same manufacturer may run concurrently.

1.04 INSTALLATION INSPECTION SERVICES

A. The Contractor shall furnish the services of a competent factory representative to inspect the installation of each piece of equipment prior to start-up and functional testing in accordance with the requirements of these Specifications. The time required shall be shown in the equipment sections of these Specifications, but shall be no less than one, eight (8) hour day.

B. The factory representative shall certify that the equipment has been installed in accordance with the manufacturers' recommendations and is ready for start-up.

1.05 START-UP SERVICES

A. The Contractor shall furnish the services of a competent factory representative to supervise the start-up, functional testing, and field performance testing for each item or system installed in accordance with Section 01650-Facility Start-Up and the equipment sections shown in Divisions 2 through 16 of these Specifications. The time required shall be shown in the equipment sections, but shall be no less than one, eight (8) hour day.

1.06 OPERATOR TRAINING SERVICES

A. The Contractor shall furnish the services of a factory representative to train the Owner's personnel in the operation and maintenance of each item installed under these Specifications. The time required shall be shown in the equipment sections, but shall be no less than one, eight (8) hour day.

END OF SECTION 01640

SECTION 01650
FACILITY STARTUP

PART 1 - GENERAL

1.01 RELATED SECTIONS

A. The follow Specifications are related to this Specification:

1. Section 02730 – Sewers, Storm Drains and Grate Inlets
2. Section 03300 – Cast-in-Place Concrete
3. Section 03414 – Prestressed Circular Concrete Tanks.
4. Division 11 – Equipment
5. Division 13 – Special Construction
6. Division 15 – Mechanical
7. Division 16 - Electrical

1.02 DEFINITIONS

A. Pre-Operational Checkout (Step 1): Are those documented physical checks (tests) that must occur to ensure that a structure or an item of equipment or equipment system is ready for functional testing. Example components of pre-operational checkout /testing include but are not limited to the following:

1. Pressure and/or leakage tests, water-tightness of concrete structures, and pipe testing.
2. Electrical testing, resistance testing in accordance with NETA - Section 16T. Also, phase/motor rotation checks.
3. Instrument calibration and loop tests. Pre-operational check-out of instrumentation system controls.
4. Pre-operational checkout of mechanical and HVAC equipment to include alignment, lubrication, and other checks as recommended by the manufacturer.

B. Functional Test: (Step 2): A test or tests, in the presence of the Engineer and Owner, to demonstrate that the installed equipment or system meets manufacturer's installation and adjustment requirements and other requirements.

1. The testing of the individual items of equipment within a system will be performed under simulated conditions to determine contract compliance. This test will utilize potable water or another acceptable substitute test media. The equipment will be operated long enough to gather information (data) on noise, temperature, vibration, performance characteristics, and to make initial adjustments of any applicable controls. Initial baseline data will be gathered on equipment with motors greater than one (1) horsepower including amperage, bearing temperatures, and vibration.
2. The instrumentation and control field testing (loop checks from the field devices to PLC or distributed control systems as well as field calibrations), will be accomplished during the pre-operational checkout and functional testing stages as defined above. This includes field

verification of all control system inputs/outputs and setting of level switches, pressure switches and other field devices as well as PLC setpoints for control and alarm functions.

C. Operational Test (Step 3): A test, performed in the presence of the Engineer and Owner, of all components within a system collectively to ensure that the system and all of its integral components function as intended. Water and/or other temporary media supplied by the Contractor will be circulated through the completed facility/system for five (5) days with systems being operated under various loading conditions as proposed by the Contractor and approved by the Engineer. Upon completion of this operational test period the Contractor may apply for a Substantial Completion certificate.

1. The instrumentation and control system automatic function for the overall system will be verified for all modes of operation and documented during the operational testing stage as described above.
2. The diversion pump station system operational test is anticipated to be independent of the equalization tank and jet mix pump station system operational test with provisions for flow recirculation internal to each system to facilitate testing and minimize potable water consumtion. A tee is installed on the 48 inch diversion pipeline anticipating the installation of temporary recirculating loops for operational testing.

D. Punchlist: All items that could affect, or be affected by, the full time operation of the system (as deemed critical by the Engineer) must be complete prior to the Operational Test phase.

E. Acceptance Test (Step 4): The start-up and operation of the systems installed, under actual operating conditions, as part of the sewer system. The Contractor shall be responsible for operation and maintenance of the complete facility during the Acceptance Test period. The Acceptance Test period shall begin at the date of Substantial Completion. The duration of Acceptance Testing shall be as follows:

1. A period that covers a minimum of eight (8) diversion events of which the peak pumped flow during at least one (1) diversion event exceed 50 MGD, or
2. A six month period if eight (8) diversion events do not occur in the six (6) month period following substantial completion.

F. During the Acceptance test period, the Owner may provide operating staff to monitor the facility operation, During the Acceptance Test period, the Contractor shall also notify the Owner of the beginning of every event so that the Owner can have operating personnel or other individuals on site for observation and to monitor the Acceptance Testing.

G. Performance Test: Any special tests performed in the presence of the Engineer and Owner called for by the specific equipment or system specification, which are to be performed in addition to the installation and acceptance tests noted in this start-up specification (pre-operational checkout, functional testing, operational testing, and acceptance testing).

H. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment. Examples of systems on this Project are as follows:

1. Pumps, motors, and controls.
2. Instrumentation and control system(s).

I. Substantial Completion: The date certified by the Engineer when all or a part of the work as identified in the Engineer's certification, has been properly installed per the contract documents and manufacturer recommendations, deemed operational through the completion of the Pre-operational checkout, Functional Test, Operational Test, has all test documents with Operation and Maintenance manuals delivered, is sufficiently completed in accordance with the requirements of the Contract Documents and can be utilized for the purposes for which it is intended.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Administrative Submittals:
   a. Functional and performance test schedules and plan for equipment, units, and systems at least fourteen (14) days prior to start of related testing. Include test plan, procedures, and log format.
   b. Schedule and plan of facility startup activities at least twenty-one (21) days prior to commencement.
2. Quality Control Submittals:
   a. Manufacturer's Certificate of Proper Installation as required.
3. Test Reports: Functional, Operational, Acceptanceand Performance testing reports, in format acceptable to Engineer and certification of functional and performance test for each piece of equipment or system specified. Reports shall include, logs for each component, device, setpoint and other parameters tested indicating flow rates, levels, and other operational data and verification of successful completion.
4. Certifications of Calibration: Testing equipment.

1.04 CONTRACTOR FACILITY STARTUP RESPONSIBILITIES

A. General:

1. The Contractor shall provide, at no expense to the Owner, all power, fuel, compressed air supplies, water, and chemicals; as well as all labor, temporary piping, valves, instrumentation, heating, ventilating, and air conditioning or bypass pumping, for any areas where the Facilities are not complete and operable at the time of Operational Testing and its prerequisites. Contractor shall provide all other items and work required to complete Operational Testing and its prerequisites. Temporary facilities shall be maintained until permanent systems are in service.
2. Acceptance testing under actual operating conditions shall be completed only after satisfactory completion of Operational Testing with all systems operational. No temporary systems will be used during Acceptance testing.
3. The Contractor shall provide, at no expense to the Owner, temporary piping, valves and appurtenances to create re-circulating loops capable of producing conditions simulating design conditions.
4. The Contractor shall provide all necessary qualified operations personnel and manufacturers' field service personnel of the major equipment suppliers on an eight (8) hour per day basis at

the facilities and on a twenty-four (24) hour per day basis locally during the operational test period.

5. The Contractor shall provide all necessary qualified operations personnel on a twenty-four (24) hour per day basis locally and have manufacturers' field service personnel of the major equipment suppliers available on an emergency response basis during the acceptance test period.

6. At no time during startup shall the Contractor allow the facility to be operated in a manner which subjects equipment to conditions that are more severe than the maximum allowable operating conditions for which the equipment was designed.

7. The Contractor shall make provisions to conserve the water used on site for testing purposes. Recirculation or reuse of water shall be required to limit the amount of water discharged to the Owner's existing trunk sewer.

B. Tie-Ins or Modifications To The Existing Systems

1. Anytime the Contractor ties into or modifies an existing system, a detailed Work Plan shall be required. Submittal of this Work Plan must be a minimum of thirty (30) days in advance of commencement of the subject work. This Work Plan shall include a detailed description of the work, a step-by-step plan of the modification or tie-in, a detailed timeline schedule, a detailed list of materials and equipment required, demonstrated communications capacity, and a listing of any gates or valves which must be operated. Working drawings shall be submitted as required under GC-28 for any permanent or temporary structural modifications. A temporary safety plan covering the period of the work, and a listing of contingency plans and supplies, including but not limited to spill prevention planning and spill containment kits, shall be required. A coordination meeting with the Owner's operating staff, the Contractor and the Engineer must be held at least seven (7) days prior to the commencement of the modification or tie-in. The day before the commencement of the modification or tie-in, a final coordination meeting shall be held giving final detailed work assignments to all parties involved.

2. The Owner and Engineer have the right to require, at no additional cost to the Owner, stand-by equipment on any item(s) deemed critical enough to delay the work. The Contractor shall have available stand-by personnel to supplement the committed forces should problems arise. The Contractor is responsible for meeting all OSHA standards including entrance and exit safety, confined space entry, fall protection, scaffolding, rigging, etc.

C. Contractor's Startup Quality Assurance Manager

1. The Contractor shall appoint an operations engineer or equally qualified operations specialist as Startup Manager to manage, coordinate, and supervise all aspects of the Contractor's startup and testing program including, but not limited to those components of the program as listed with this appendix. The Startup Manager shall have at least five (5) years of total experience, or experience on at least five separate projects, in managing the startup commissioning of mechanical, electrical, instrumentation, HVAC, and piping systems. Operations engineers shall be graduates from a minimum 4-year course in mechanical, civil or a related program of study. Operations specialists shall have equivalent documented experience in operation and maintenance. Contractor shall submit the Startup Manager's resume for review and approval a minimum of six (6) months prior to any testing, or prior to 50% completion of the first constructed system.

D. Contractor's Testing Team

1. Contractor's Testing Team shall include at a minimum the Quality Assurance Manager, qualified Mechanical/Equipment Foreman, qualified Electrical Journeyman, qualified Instrument Technician, and qualified/Certified Operations personnel.

2. Contractor is responsible to have the appropriate personnel, procedures, and test forms at the test site when performing a scheduled checkout/testing activity that is to be witnessed by the Engineer.

E. Test Equipment

1. All test equipment (gauges, meters, thermometers, analysis instruments, and other equipment) used for calibrating or verifying the performance of equipment installed under this contract shall be calibrated to within plus or minus two (2) percent of actual value at full scale. Test equipment employed for individual test runs shall be selected so that expected values as indicated by the detailed performance specifications will fall between 60 and 85 percent of full scale. Pressure gages shall be calibrated in accordance with ANSI/ASME B40.1. Thermometers shall be calibrated in accordance with ASTM E77 and shall be furnished with a certified calibration curve.

2. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

3. Calibration equipment/test instruments utilized for start-up and testing shall be documented to include identification (by make, manufacturer, model, and serial number) of the test equipment, date of original calibration, subsequent calibrations, calibration method, and test laboratory as well as documentation of current calibration.

4. All analysis instruments, sensors, gauges, and meters used for performance testing shall be subject to recalibration to confirm accuracy after completion, but prior to acceptance of each performance test. All analysis instruments, sensors, gages, and meters installed under this contract shall be subject to recalibration prior to Acceptance.

5. Test equipment used to simulate inputs and read outputs shall have a rated accuracy at the point of measurement at least three (3) times greater than the component under test. Buffer solutions and reference fluids shall be provided as necessary for tests of analytical equipment.

1.05 OWNER/ENGINEER FACILITY STARTUP RESPONSIBILITIES

A. General:

1. Review Contractor's test plan and schedule.

2. Witness each functional, operational (portions of) and performance test.

3. Coordinate other Owner operations, if necessary, to facilitate Contractor's tests.

B. Acceptance Test Period:

1. Operate process units and equipment, with support of Contractor.

2. Provide sampling, labor, and materials as required and provide laboratory analyses.

3. Provide operational data to the Contractor for Contractor's completion of Acceptance Test Report(s).

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 START-UP PROGRAM IMPLEMENTATION

A. Start-Up Meetings

1. The Contractor shall schedule and conduct regular periodic start-up meetings (separate from regular progress meetings). The start-up meetings will be held at least every ten (10) days (once start-up planning commences) and may be scheduled at a more frequent interval by the Engineer if necessary. Start-up meetings shall be held at a location designated by the Contractor and approved by the Engineer.

2. Start-up meetings shall be attended by the Engineer, Contractor, Subcontractors and suppliers as appropriate to the agenda and others as required.

3. The meeting agenda shall generally include review and approval of minutes of previous meeting, review of start-up progress since the previous meeting, field observations, problems, and conflicts, problems which impede Start-Up Schedule, delivery schedules, corrective measures and procedures to regain the start-up schedule, revisions to Start-Up Schedule, progress and schedule of the preceding work period, coordination of schedules, review of start-up submittal schedules and status, status of start-up related requests for information, and any other business deemed appropriate.

B. Start-up and Testing Schedule

1. The Contractor shall produce an overall testing schedule setting forth the sequence contemplated for performing the test work. The schedule shall be in bar chart form, plotted against calendar time, shall detail the equipment and systems to be tested, and shall be coordinated with the Construction Schedule. The testing schedule shall show the contemplated start date, duration of the test and completion of each test.

2. The preliminary test schedule shall be submitted with the overall Start-up Acceptance Test Plan. The Engineer will not witness any testing work until the Contractor has submitted a schedule to which the Engineer takes no exception. The test schedule shall be updated weekly, and presented at each start-up meeting, showing actual dates of test work, indicating systems and equipment testing completed satisfactorily and meeting the requirements of the Contract Documents, and also re-forecast the upcoming testing and reflect any schedule adjustments accompanied by written reason for the change. The Contractors baseline start-up and testing schedule is to be submitted with the overall test plan.

C. Documentation

1. The Contractor shall develop a records-keeping system to document all activities associated with Acceptance Testing and its prerequisites.

2. Equipment and system documentation shall include date of test, equipment number or system name, nature of test, test objectives, test results, test instruments employed for the test, and signature spaces for witness by the Engineer, the Contractor's Start-Up/Quality

Assurance Manager, and the Equipment Manufacturer. A separate file shall be established for each system, organized by start-up phase (i.e., pre-operational, functional, operational, acceptance test phase), and will include sections for each item of equipment. These files shall include the following information and documentation as a minimum. Test plan and documentation organization shall be as follows:

D. Test Plan Organization

1. Index.
2. Schedule
3. Steps 1 and 2: Each type of equipment will have its own section within the system and include the following:
   a. The detailed pre-operational test procedures.
   b. The detailed functional test procedures.
   c. Customized mechanical equipment, customized electrical, and customized instrumentation pre-operational, and functional test forms as applicable.
   d. Other pre-operational test documentation as required for piping and mechanical equipment.
4. Step 3: A separate section will be created for the system operational testing and include the following:
   a. Detailed plans for recirculation of flows and producing conditions simulating design conditions.
   b. The detailed five (5) day operational test procedure.
   c. A detailed operational system check/sign-off sheet (based on system tests, control checks, and interlock checks to be performed).
   d. System operational test completion sign-off form.
5. Step 4: Another section is to be designated for the Acceptance Testing and include the following:
   a. Detailed Work Plans, Communications Plan, Safety Plan, and contingencies, as well as other requirements outlined under tie-ins and modifications to existing systems (SC-24).
   b. Test overview and proposed spreadsheet forms to be utilized by the Contractors staff to record appropriate operational and performance data for each diversion event during the Acceptance Test period.
   c. System acceptance test completion/sign-off form.
6. The forms attached to Section 01600-General Material and Equipment Requirements are samples showing the required format and level of detail for documentation. The Contractor is advised that these are samples only and are not specific to this project nor to any item of equipment or system to be installed under this contract. The Contractor shall develop test documentation forms specific to each item of equipment and system installed under this contract. Acceptable example documentation forms for all systems and items of equipment shall be produced and submitted for review and approval by the Engineer as a condition precedent to the Contractor's receipt of progress payments in excess of 60 percent of the contract amount. Once the Engineer has reviewed and taken no exception to the forms proposed by the Contractor, the Contractor shall produce customized forms for each item of equipment and system and include these individual forms in the overall test plan that will be submitted for approval.

7. The complete test plan and all its sections are to be submitted 60 days prior to any testing and approved, Code 1 or Code 1C, prior to the start of any testing.

3.02 TEST PLAN IMPLEMENTATION

A. This program will be implemented in 4 distinct steps (phases). These steps are the Pre-**Operational Checkout**, the **Functional Testing**, the **Operational Testing**, and the **Acceptance Testing**.

3.03 STEP 1 – PRE-OPERATIONAL CHECKOUT AND TESTING

A. The first step involves the **Pre-operational checkout**. This would include multi-discipline work completion and physical checkout. The **Pre-operational Completion** and **Pre-operational test reports** include the following required testing. Examples of these documented tests include, but are not limited to:

1. Field pressure/leakage test reports for all pipe, valves, structures and appurtenances.
2. Wire insulation megohm reports for all 120V and greater wire.
3. Phasing, ratio, polarity, ground resistance, current injection, insulation resistance, over potential test, and circuit breaker contact resistance reports for medium voltage switchgear.
4. Insulation power factor and resistance test reports for surge arresters.
5. Megger reports for Unit Substations, Three Winding Transformers, and 460V motor control centers.
6. Megger reports and ground connection tests.
7. Loop Status Report and Component Calibration forms.
8. Equipment installation checkout forms.

B. Pipe Testing

1. Prior to application of insulation on exposed piping, test the piping systems at the appropriate pressure according to the requirements of related piping specifications. All buried piping shall be tested prior to any backfill being placed, unless prior approval by the Engineer is given in writing. Test duration shall be one-hundred twenty (120) minutes for all tests and witnessed by the Engineer. Isolate equipment that may be damaged by the specified test conditions. Testing shall be performed using calibrated test gages and calibrated volumetric measuring equipment to determine leakage rates. Each test gage shall be selected so that the specified test pressure falls within the upper half of the gage's range. Testing shall include existing piping systems that connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping that fails the test shall be repaired and re-tested.
2. For gas, air, and vapor systems, the allowable leakage rate for systems tested with air shall be based on a maximum pressure drop of 5 percent of the specified test pressure for the duration of the period. Prior to starting a test interval using air, the air shall be at ambient temperature and specified test pressure. The allowable leakage rate for hazardous gas systems, insulated systems, and systems tested with water shall be zero at the specified test pressure throughout the specified test period. Hazardous gas systems shall include sulfur dioxide, chlorine, propane, sludge gas and natural gas systems. Testing medium shall be as

follows for gas, air, and vapor systems:

Pipeline size	Specified test pressure	Testing medium
2 inch and smaller	75 psi or less	Air or water
2 inch and smaller	Greater than 75 psi	Water
Greater and 2 inch	3 psi or less	Air or water
Greater and 2 inch	Greater than 3 psi	Water

3. For liquid systems, leakage shall be zero at the specified test pressure throughout the specified duration for exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Leakage from other buried liquid piping systems shall be less than 0.02 gallon per hour per inch diameter per 100 feet of buried piping. Drain systems, other than pumped drain systems, shall be tested in accordance with Georgia State Minimum Standards.

4. For hydraulic and lube oil systems, upon completion of cleaning, all field connections shall be completed and the system tested at the specified pressure. Pressure loss shall be zero for the specified test period. For fluid power systems, the manufacturer shall supervise the installation and testing of all system components including all field piping.

C. Pipe System Cleaning and Flushing

1. Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, regulating, or instrumentation equipment. The Contractor may, at his option, clean and test sections of buried or exposed piping systems. Use of this procedure, however, will not waive the requirement for a full pressure test of the completed system. Unless specified otherwise, piping twenty-four (24) inches in diameter and smaller shall first be cleaned by pulling a tightly fitting cleaning ball or swab through the system. Piping larger than twenty-four (24) inches in diameter may be cleaned manually or with a cleaning ball or swab.

   Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs that remain visible from the outside when the screens are in place, shall be inserted in pipelines at the suction of pumps and compressors in accordance with the following table:

Equipment suction or piping size, inches	Maximum screen opening, inches
0 to 1	1/16
1-1/4 to 3	1/4
3-1/2 to 6	1/2
Over 6	1

2. The Contractor shall maintain the screens during all testing prior to the start of Acceptance testing. In special cases, screens may be removed as required for performance tests. Systems handling solids are exempted.

3. Gas and air system piping six (6) inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than six (6) inches shall be cleaned by having a swab or "pig" drawn through the separate reaches of pipe. After connection to the equipment, it shall then be blown out using the equipment. Upon completion of cleaning, the piping shall be drained and dried with an air stream.

4. After completion of cleaning, liquid systems, unless otherwise specified, shall be flushed with clean water. With temporary screens in place, the liquid shall be circulated through the

piping system using connected equipment for a minimum period of fifteen (15) minutes and until no debris is collected on the screens. Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

D. Equipment – Pre-Operational Checkout

1. Equipment pre-operational checks and tests shall include, but are not limited to, the following:
2. Check for proper installation, alignment, support, and anchorage per the applicable manufacturers installation, operation and maintenance manual and in accordance with the contract documents.
3. Check the equipment for proper adjustment, packing of seals, lubrication, drive connection, motor connection, and belt/chain tension per the applicable manufacturers installation, operation and maintenance manual and in accordance with the contract documents.
4. Check the associated process, seal water, cooling water, drain, and vent pipe connections for proper routing and connection. Check to ensure the pipe testing was performed and signed as completed for all the associated piping.
5. Ensure that the equipment is clean and free of any construction debris that could potentially cause a malfunction.
6. Ensure that all safety guards, signage, and other safety measures such as hearing protection, etc., are in place.
7. Have the manufacturer's representative perform all pre-operational tests per the manufacturers' recommendations and review the equipment installation and sign the Manufacturer's Installation portion of the certification form. If the manufacturer's representative brings his own checklist, obtain a copy of the completed form and attach it to the Contractors completed forms. Note that the manufacturer must also fill out the contract approved checkout form (their own form will not serve as a substitute).
8. All gates and valves associated with the equipment system must be checked for proper installation, adjustment, and lubrication per the manufacturer's recommendations.

E. Concrete Structure Water-tightness – Pre-Operational Checkout

1. Pre-stressed circular concrete tanks shall be hydrostatically tested per Section 03414 – Prestressed Circular Concrete Tanks.
2. All other water-retaining concrete structures shall be tested for water-tightness in accordance with ACI 350.1R. The maximum allowable leakage rate shall be 0.075% over a twenty-four (24) hour period.

F. Electrical Pre-Operational Checks/Tests

1. Prior to energizing electrical circuits, use a 1,000-volt megohmeter to measure insulation resistance on conductors and insulated parts of electrical equipment. All measurements shall meet or exceed the appropriate ICEA, NEMA, or ANSI standard. Any insulation resistance less than ten (10) megohms is unacceptable. Record results, as well as ambient temperature.
2. Measure phase-to-ground insulation resistance for all circuits 120 volts and above, with the exception of lighting circuits. Measurements may be made with motors and other equipment

connected, except that solid state equipment shall be disconnected unless the equipment is normally tested by the manufacturer at voltages in excess of 1,000 volts DC.

3. Complete Test Form for each installed motor. Measure the insulation resistance of all motors before connection. Measure the insulation resistance for all motors at the time of delivery as well as when connected. Insulation resistance values less than ten (10) megohms are not acceptable.

4. Adjust and make operative all protective devices. Perform a functional check of the control circuit prior to energizing the equipment.

5. Review all associated electrical terminations, switches, and breakers for satisfactory installation.

G. Individual Component/Instrument Calibration Pre-Operational Check/Test

1. Each instrument and final element shall be field calibrated in accordance with the manufacturer's recommended procedure. Instruments shall then be tested in compliance with ISA S51.1 and the data entered on the applicable test report form. Alarm trips, control trips, and switches shall be set to initial values specified in the design at this time. Final elements shall be checked for range, dead band, and speed of response.

2. Calibration of analysis instruments, sensors, gauges, and meters installed under this contract shall proceed on a system-by-system basis. No equipment or system operational, performance or acceptance tests shall be performed until instruments, gages, and meters to be installed in that particular system have been calibrated and the calibration work has been witnessed by the Engineer.

3. Testing of instrument process piping/tubing, wiring, and individual components shall be completed and documented on the approved test forms provided to the Engineer as part of the pre-operational testing phase and prior to commencement of individual loop testing conducted during the pre-operational functional test phase.

4. Any component which fails to meet the required tolerances shall be repaired by the manufacturer or replaced, and the above tests repeated until the component is within tolerance.

5. System instrumentation equipment supplied and installed must also be reviewed for proper installation and termination as part of the pre-operational checkout.

H. Pre-Operational Checkout Summary

1. The pre-operational checkout and testing for each item shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved pre-operational test forms.

2. The Contractor shall complete the pre-operational testing requirements listed above, at a minimum, for each item of mechanical, electrical, instrumentation, and HVAC equipment prior to beginning any functional testing with regard to the equipment or the systems in which the equipment functions.

3. Provide Pre-Operational Test summary including all signed forms and checklists to document that the work has been successfully completed.

3.04 STEP 2 – FUNCTIONAL TEST

A. General

1. The second step in the program is the **Functional Test.** This is the functional testing of the equipment. These tests begin for each item of equipment only after the **Pre-operational Checks** have been completed for all components for the particular equipment.

2. The functional testing for each item of equipment shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved functional test forms.

3. Once 1) all affected equipment has been subjected to the required pre-operational testing procedures; and 2) the Engineer has witnessed and has not found deficiencies in that portion of the work, individual items of equipment and systems may be started and operated under simulated operating conditions to determine as nearly as possible whether the equipment and systems meet the Contract Documents. It is anticipated that potable water will be employed as the test medium and be supplied by the contractor. The contractor may propose alternate sources of water for testing to minimize the potable water demand. The equipment shall be operated for a sufficient period of time to determine machine operating characteristics, including noise, temperatures, and vibration; to observe performance characteristics; and to permit initial adjustment of operating controls. When testing requires the availability of auxiliary systems such as looped piping, electrical power, compressed air, control air, or instrumentation which have not yet been placed in service, the Contractor shall provide acceptable substitute sources, capable of meeting the requirements of the machine, device, or system at no additional cost to the City. Disposal methods for test media shall be subject to review by the Engineer. During the functional test period, the Contractor shall obtain baseline operating data on all equipment with motors greater than one (1) horsepower to include amperage, bearing temperatures, and vibration. The baseline data shall be collected for use in the CMMS.

4. Test results shall be within the tolerances set forth in the detailed specification sections of the Contract Documents and as indicated in the Contractors functional test plan and the manufacturers criteria. If no tolerances have been specified, test results shall conform to tolerances established by recognized industry practice. Where, in the case of an otherwise satisfactory functional test, any doubt, dispute, or difference should arise between the Engineer and the Contractor regarding the test results or the methods or equipment used in the performance of such test, than the Engineer may order the test to be repeated at the Contractors expense. Where the results of any functional test fail to comply with the Contract Documents for such test, then such repeat tests as may be necessary to meet the Contract Documents shall be made by the Contractor at his expense.

B. The **Functional Test** reports (test documentation) include the required testing. Examples of these types of reports include, but are not limited to:

1. The Functional Field Test of valves.

2. The cycling/functions check of the sluice gates, and stop logs.

3. The leakage testing of sluice gates, and stop logs in accordance with AWWA specifications.

4. Vibration, noise, and capacity testing of Pumps.

5. Loop functional test for Instrumentation and Control.

C. Process/Mechanical/Equipment – (Functional Testing)

1. During the Functional Verification Check and Testing process, the Contractor and the various Manufacturer's Technical representatives shall examine and record the initial start-up performance of the components provided by their respective firms in accordance with the Contractors approved functional test procedure.
2. The initial operation, testing and adjustment shall be as required to prove that the equipment has been installed properly and operates under the conditions specified.
3. Upon completion of this work, the manufacturer's field service technician shall complete the Contractors approved functional test form as well as their own signed report to record the results of his/her inspection, operation, adjustments and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results if such are specified, and suggestions for precautions to be taken to ensure proper maintenance.

D. Electrical - (Functional Testing)

1. The Contractors' electrician shall be present during all testing to confirm the electrical testing, provide troubleshooting assistance, repair as needed, and assist in gathering baseline data such as motor amperages.
2. Energize each control circuit and operate each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. The Contractor shall submit a description of his proposed functional electrical test procedures as part of the testing plan.
3. Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

E. Instrumentation and Control – (Functional Testing)

1. The Contractors' instrumentation representative shall be on site full time during the functional test phase to perform loop checks and to support the Contractors start-up team as needed. Any packaged equipment or manufacturer supplied control panels must be field tested to verify all control interlocks and control functions during this phase of testing by the equipment supplier. Note that the Contractors functional test procedure for each piece of equipment shall define each interlock to be tested.
2. Each instrument loop shall be tested. This testing shall check operation from transmitter to readout components. Signals shall be generated utilizing the primary measuring elements where possible. Signals shall be injected only if primary element is unavailable.
3. If any output device fails to indicate properly, corrections to the loop shall be made as necessary and the test repeated until all instruments operate properly.

F. Functional Testing Summary

1. The functional testing for each item of equipment, electrical, and instrumentation shall be carried out in accordance with the Contractors submitted and approved procedures and documented on the Contractors approved functional test forms. A Functional Test Report shall be provided compiling all results and testing forms for the project.

3.05 STEP 3 – OPERATIONAL TESTING

A. The third step in the program is the Operational Testing. This step begins after all Pre-operational checks and Functional tests have been satisfactorily completed. The Contractor shall plan his activities to allow for Owner witnessing of all tests and shall provide twenty-four (24) hours advance notice of all testing activities.

B. The Contractors operational test plan shall be a detailed procedure to confirm all System Automatic Mode functions, verify all system interlocks and alarms, and reconfirm all equipment functions and controls. All design and performance criteria will be demonstrated and documented during this five (5) day period. The Contractors manufacturer, electrical, and instrumentation representatives will be on site on an eight (8) hour a day basis and locally on a twenty-four (24) hour a day basis during this period.

C. In the event of failure to demonstrate satisfactory performance of the system on the first or any subsequent attempt, all necessary alterations, adjustments, repairs, and replacements shall be made. When the system is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the system has operated continuously to the satisfaction of the Owner and Engineer, for the specified duration.

D. Prerequisites

1. Prior to the Owner's issuance of a Certificate of Substantial Completion for the Work, the contractor shall perform Operational Testing. Any failures of process, equipment, or systems shall result in re-starting the operational testing period. During this test period the facility must meet the following criteria:
   a. Satisfactory operation at the rated capacity;
   b. Operation without violating the Contract Document requirements;
   c. Operation without creating a materially unsafe condition, nuisance condition or unacceptable risk to personnel, facilities, or the public;
   d. Operation without producing, air or water emissions, traffic, noise, odors, or other environmental impacts that the Owner, in its sole discretion, determines to be unacceptable to public safety, health, or welfare.

E. OperationalTesting Summary

1. An Operational Testing report shall be provided compiling all results of the testing including test forms, logs for each component, device, setpoint and other parameters tested indicating flow rates, levels, and other operational data and verification of successful completion.

3.06 STEP 4 – ACCEPTANCE TESTING

A. The fourth step in the program is **Acceptance Testing**. The Acceptance test period shall begin at the date of Substantial Completion when all new systems and equipment have successfully completed the operational test period.

B. The Contractor shall provide operation staff to operate and maintain the facility throughout the Acceptance Test period.

C. All spare parts, safety equipment, tools and maintenance equipment, lubricants, approved operation and maintenance data and the specified operation and maintenance instruction shall be

provided prior to the startup. The Owners and Contractors operation staff shall also receive training from the equipment and instrument suppliers, etc. prior to Acceptance Testing/start-up.

D. As part of the acceptance test plan the Contractor shall submit detailed Staffing Operations Plans, Work Plans, Communications Plan, Safety Plan, contingencies, and other requirements as outlined under tie-ins and modifications to existing systems (SC-24). Also an acceptance test overview and proposed spreadsheet forms to be utilized to record appropriate operational and performance data for each diversion event during the acceptance testing.

E. Instrumentation Acceptance Test

1. The instrument loop acceptance test shall fully demonstrate stable operation of the loop under normal operating conditions. This test shall be witnessed by the Engineer and performed and documented by the Instrumentation System Supplier.
2. Tuning parameters (proportional gain, integral time constant, and derivative time constant) for each control loop shall be adjusted to provide 1/4 amplitude damping unless otherwise specified and witnessed during system supplier factory testing.

F. Acceptance Test Report

1. A final Acceptance Testing report shall be provided compiling all results of the acceptance Test period. The report shall cover Dry Weather and Wet Weather events. An independent test report shall be provided for each Wet Weather event including test forms, logs for each component, device, setpoint and other parameters tested indicating flow rates, levels, and other operational data and verification of successful completion. The final Acceptance Test report shall compile all Wet Weather events and a summary of Dry Weather operation Flow Meters
2. Liquid flow meters, including all open channel flow meters and all meters installed in pipelines with diameters greater than two (2) inches shall be calibrated insitu using either the total count or dye dilution methods. Flow meter calibration work shall be performed by individuals skilled in the techniques to be employed. Calibration tests for flow metering systems shall be performed over a range of not less than 10 percent to at least 75 percent of system full scale. At least five (5) confirmed valid data points shall be obtained within this range and witnessed by the Engineer. Confirmed data points shall be validated by not less than three (3) test runs with results which agree within plus or minus two (2) percent.

G. In the event of failure to demonstrate satisfactory performance of the system on the first or any subsequent attempt, all necessary alterations, adjustments, repairs, and replacements shall be made. When the system is again ready for operation, it shall be brought on line and a new test shall be started. This procedure shall be repeated as often as necessary until the system has operated continuously to the satisfaction of the Owner and Engineer, for the specified duration.

H. All completed Acceptance test forms will be placed into the master record test plan binder and provided to the Owner prior to acceptance.

END OF SECTION 01650

SECTION 01664
TRAINING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Related work specified elsewhere;

1. Section 01640- Manufacturer's Services.
2. Section 01650- Facility Startup.
3. Section 13000- Instrumentation, Control and Monitoring System General Requirements.

B. This section contains requirements for training the Owner's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems installed under this Contract.

1.02 QUALITY ASSURANCE

A. Where required by the detailed specifications, the Contractor shall provide on-the-job training of the Owner's personnel. The training sessions shall be conducted by qualified, experienced, factory-trained representatives of the various equipment manufacturers. Training shall include instruction in both operation and maintenance of the subject equipment.

1.03 SUBMITTALS

A. The following information shall be submitted to the Engineer in accordance with paragraph GC-28 of the General Conditions. The material shall be reviewed and accepted by the Engineer as a condition precedent to receiving progress payments in excess of 75 percent of the Contract amount and not less than three (3) weeks prior to the commencement of training.

1. Lesson plans for each training session to be conducted by the manufacturer's representatives. In addition, training manuals, handouts, visual aids, and other reference materials shall be included.
2. Subject of each training session, identity and qualifications of individuals to be conducting the training, and tentative date and time of each training session.

PART 2 - PRODUCTS

2.01 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this contract. Training shall take place at the site of the work after the equipment has been installed and tested and under the conditions specified in the following paragraphs. Approved operation and maintenance manuals shall be available at least thirty (30) days prior to the date scheduled for the individual training session.

2.02 LOCATION

A. Training sessions shall take place at the site of the Work.

2.03 LESSON PLANS

A. Formal written lesson plans shall be prepared for each training session. Lesson plans shall contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan shall contain a time allocation for each subject.

B. One complete set of originals of the lesson plans, training manuals, handouts, visual aids, and reference material shall be the property of the Owner and shall be suitably bound for proper organization and easy reproduction. The Contractor shall furnish ten (10) copies of necessary training manuals, handouts, visual aids and reference materials at least one (1) week prior to each training session.

2.04 FORMAT AND CONTENT

A. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization:
   a. Review catalog, parts lists, drawings, etc., which have been previously provided for the plant files and operation and maintenance manuals.
   b. Check out the installation of the specific equipment items.
   c. Demonstrate the installed unit and indicate how all parts of the specifications are met.
   d. Answer questions.
2. Safety:
   a. Using material previously provided and installed equipment, review safety references.
   b. Discuss proper precautions around equipment.
3. Operation:
   a. Using material previously provided and installed equipment, review reference literature.
   b. Explain all modes of operation (including emergency).
   c. Check out Owner's personnel on proper use of the equipment.
4. Preventive Maintenance:
   a. Using material previously provided and installed equipment, review preventive maintenance (PM) lists including:
      i) Reference material.
      ii) Daily, weekly, monthly, quarterly, semi-annual, and annual jobs.
   b. Show how to perform PM jobs.
   c. Show Owner's personnel what to look for as indicators of equipment problems.
5. Corrective Maintenance:
   a. List possible problems.
   b. Discuss repairs; point out special problems.
   c. Open up installed equipment and demonstrate procedures, where practical.

6. Parts:
   a. Show how to use previously provided parts list and order parts.
   b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.
7. Local Representatives:
   a. Where to Order Parts: Name, address, and telephone.
   b. Service Problems:
      i) Who to call.
      ii) How to get emergency help.
8. Operation and Maintenance Manuals:
   a. Review any other material submitted.
   b. Update material, as required.

2.05 VIDEO RECORDING

A. The Owner will retain the services of a commercial video taping service to record each training session. After taping, the material may be edited and supplemented by the Owner with professionally produced graphics to provide a permanent record. The Contractor shall advise all manufacturers providing training sessions that the material will be video taped and shall make available to the Owner's videotaping Contractor such utility services and accommodation as may be required to facilitate the production of the video tape record.

PART 3 - EXECUTION

3.01 GENERAL

A. Training shall be conducted in conjunction with the operational testing and commissioning periods. Classes shall be scheduled such that classroom sessions are interspersed with field instruction in logical sequence. The Contractor shall arrange to have the training conducted on consecutive days, with no more than six (6) hours of classes scheduled for any one day. Concurrent classes shall not be allowed. Contractor/Manufacturer is to plan for up to three (3) classes in any twenty-four (24) hour period to ensure all shifts are properly trained

B. Acceptable operation and maintenance manuals for the specific equipment shall be provided to the Owner prior to the start of any training. Video taping shall take place concurrently with all training sessions.

C. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

   1. As a minimum classroom equipment training for operations personnel will include:
      a. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.
      b. Purpose and plant function of the equipment.
      c. A working knowledge of the operating theory of the equipment.
      d. Startup, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.

e. Identify and discuss safety items and procedures.

f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.

g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:
   a. Identify location of equipment and review the purpose.
   b. Identifying piping and flow options.
   c. Identifying valves and their purpose.
   d. Identifying instrumentation:
      iii) Location of primary element.
      iv) Location of instrument readout.
   e. Discuss purpose, basic operation, and information interpretation.
   f. Discuss, demonstrate, and perform standard operating procedures and routine checks.
   g. Discuss and perform the preventative maintenance activities.
   h. Discuss and perform startup and shutdown procedures.
   i. Perform the required equipment exercise procedures.
   j. Perform routine disassembly and assembly of equipment if applicable.
   k. Identify and review safety items and perform safety procedures, if feasible.

3. Classroom equipment training for the maintenance and repair personnel will include:
   a. Theory of operation.
   b. Description and function of equipment.
   c. Startup and shutdown procedures.
   d. Normal and major repair procedures.
   e. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.
   f. Routine and long-term calibration procedures.
   g. Safety procedures.
   h. Preventative maintenance such as routine lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

4. Hands-on equipment training for maintenance and repair personnel shall include:
   a. Locate and identify equipment components.
   b. Review the equipment function and theory of operation.
   c. Review normal repair procedures.
   d. Perform startup and shutdown procedures.
   e. Review and perform the safety procedures.
   f. Perform Owner approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION 01664

SECTION 01800
MAINTENANCE

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor will be required to maintain stored and installed equipment and materials until Final Acceptance of the Work as defined by the General Conditions. Work included, but is not limited to:

1. Perform all required maintenance.
2. Repair and maintain protective coatings.
3. Repair and replace scratched and damaged materials and equipment.
4. Maintain and operate new equipment placed into service.

B. Work per this Section starts on the date the equipment and materials are received and continued until the Date of Final Acceptance.

C. Contractor will monitor equipment storage and subsequently the operation and material functionality on a continual basis during the specified time period. Any deterioration of materials or malfunction of equipment will be followed by swift repair action to minimize the damage. Such repair may include repair and technical services by an independent contractor if the Engineer deems the Contractor's efforts are ineffective in correcting the problem.

D. All costs for maintenance and repair of stored and installed equipment and materials, including costs from an independent contractor, during the specified time period will be the sole responsibility of the Contractor.

END OF SECTION 01800

SECTION 02000
SITE WORK

PART 1 - GENERAL

1.01 DESCRIPTION

A. These general site work requirements apply to all site work operations. Refer to Specification sections for specific product and execution requirements.

1.02 QUALITY ASSURANCE

A. Comply with all applicable local, state, and federal requirements regarding materials, methods of work, and disposal of excess and waste materials.

B. Obtain and pay for all required inspections, permits, and fees. Provide notices required by governmental authorities.

1.03 PROJECT CONDITIONS

A. Locate and identify existing underground and overhead services and utilities within contract limit work areas. Provide adequate means of protection of utilities and services designated to remain. Repair utilities damaged during site work operations at Contractor's expense.

B. Arrange for disconnection disconnect and seal or cap all utilities and services designated to be removed before start of site work operations. Perform all work in accordance with the requirements of the applicable utility company or agency involved.

C. When uncharted or incorrectly charted underground piping or other utilities and services are encountered during site work operations, notify the Engineer and the applicable utility company immediately to obtain procedure directions. Cooperate with the applicable utility company in maintaining active services in operation.

D. Locate, protect, and maintain benchmarks, monuments, control points and project engineering reference points. Reestablish disturbed or destroyed items at Contractor's expense.

E. Perform site work operations and the removal of debris and waste materials to assure minimum interference with streets, walks, and other adjacent facilities.

F. Obtain governing authorities' written permission when required to close or obstruct street, walks and adjacent facilities. Provide alternate routes around closed or obstructed traffic ways when required by governing authorities.

G. Control dust caused by work. Dampen surfaces as required. Comply with pollution control regulations of governing authorities.

H. Protect existing buildings, paving, and other services or facilities on site and adjacent to the site from damage caused by site work operations. Cost of repair and restoration of damaged items at Contractor's expense.

I. Protect and maintain street lights, utility poles and services, traffic signal control boxes, curb boxes, valves and other services, except items designated for removal. Remove or coordinate the removal of traffic signs, parking meters and postal mail boxes with the applicable governmental agency. Provide for temporary relocation when required to maintain facilities and services in operation during construction work.

J. Preserve from injury or defacement all vegetation and objects designated to remain.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment: As selected by Contractor, except as indicated in contract documents.

PART 3 - EXECUTION

3.01 PREPARATION

A. Examine the areas and conditions under which site work is performed. Do not proceed with the work until unsatisfactory conditions are corrected.

B. Consult the records and drawings of adjacent work and of existing services and utilities, which may affect site work operations.

END OF SECTION 02000

SECTION 02050
DEMOLITION

PART 1 - GENERAL

1.01 SCOPE

A. The work covered under this Section includes furnishing all labor and equipment required to remove, handle, crush and legally dispose of all equipment, materials, wells, and piping as shown on the Drawings, and required for the completion of the Work, including all necessary excavation and backfilling.

B. The work specified herein and shown on the Drawings is intended to give a general idea of the scope of this work but must not be construed as covering it entirely. The Contractor shall visit the site and judge the amount of work required and the problems anticipated in the performance of the work.

C. Requirements for removal of pavement and abandonment of site utilities are specified in the Section 02200.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. Prior to beginning work, a schedule of demolition and detail methods to be used on each facility to be demolished shall be submitted.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. The Contractor shall furnish equipment of the type normally used in demolition including but not limited to tractors, trucks and loaders.

2.02 MATERIALS

A. All concrete, mortar, grout, and backfill used in patching, plugging or repairing shall comply in all respects with the applicable material requirements of these Specifications.

PART 3 - EXECUTION

3.01 GENERAL

A. All material shall be removed as necessary for construction, or in any event, to a minimum depth of three feet below finished grades.

B. Protection

1. Take care to prevent the spread of dust and flying particles. Sprinkle rubbish and debris with water to keep dust to a minimum.
2. Maintain adequate fire protection, including extinguisher and operative waterhose lines during demolition.

C. Personnel: Perform work by personnel experienced in this type work and in such a manner as to eliminate hazards to persons and property without interference with new work and with use of adjacent areas, public rights-of-way, utilities and structures.

D. All asbestos and hazardous materials shall be properly and legally removed and disposed of prior to any demolition.

3.02 PROTECTION OF WORK AND EXISTING FACILITY

A. Perform the work in a manner that will not damage parts of the structure, facility, or system not intended to be removed. If, in the opinion of the Engineer, the method of demolition or cutting may endanger or damage parts of the structure(s) or affect the operation of the facilities, promptly change the method when so notified by the Engineer. Perform all cutting required regardless whether such cutting is specifically indicated. Examine the existing structures, evaluate conditions to be encountered in accomplishing the work, and accommodate such requirements accordingly in the Bid Proposal.

B. The Contractor shall exercise full care and shall use such methods and equipment during removal as will maintain the usefulness of the various materials and equipment removed.

3.03 DISPOSAL

A. Disposal: All rubble and waste material shall be removed from each work area in order to provide a clean area. Such removal and cleanup is to be completed upon conclusion of daily work, outage period, or a specific work period. Removal of waste material from the work areas constitutes physical removal of the debris, rubble, or waste from the building proper or work site to a storage container or stockpile. If the material is stockpiled for later disposal, the stockpile location shall be as approved by the Engineer. Should stockpiling not be approved an appropriate container may be used, or the Contractor may dispose of the material directly. If stockpiling is approved, disposal of stockpiled materials shall be accomplished at a frequency no less than weekly. Waste material is considered to be any item or material that is removed from an existing condition and is not intended for reinstallation or salvage to the City. The Contractor shall be fully responsible for proper and legal disposal of waste materials in accordance with all federal, state and local laws at no additional cost to the City.

END OF SECTION 02050

SECTION 02110
CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, equipment, tools and incidentals required for all clearing and grubbing including, but not limited to, the removal of trees, stumps, roots, brush, structures, abandoned utilities, trash, debris and all other materials found on or near the ground surface within the construction area. Precautionary measures to prevent damage to existing features to remain shall be part of the work.

B. Clearing and grubbing operations shall be coordinated with temporary and permanent erosion control procedures.

C. Related Work specified elsewhere:

1. Section 02050 - Demolition.
2. Section 02125 - Erosion and Sediment Control.
3. Section 02200 - Earthwork.

1.02 QUALITY ASSURANCE

A. The Contractor shall comply with applicable codes, ordinances, rules, regulations, and laws of local, municipal, state or federal authorities having jurisdiction over the Project. All required permits of a temporary nature shall be obtained for construction operations by the Contractor.

B. Burning shall not be allowed.

1.03 JOB CONDITIONS

A. Location of the Work: The area to be cleared and grubbed shall be the minimum required to perform the Work.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. The Contractor shall furnish equipment with operators of the type normally used in clearing and grubbing operations including, but not limited to, tractors, trucks, loaders and root rakes.

PART 3 - EXECUTION

3.01 EXISTING TREES AND VEGETATION

A. Avoid cutting or injuring trees and vegetation outside the construction limits. The Contractor shall be responsible for damages outside these limits.

3.02 CLEARING AND GRUBBING

A. Grubbing shall consist of completely removing roots, stumps, trash and other debris in the earthwork area so that topsoil is free of roots and debris. Topsoil is to be left sufficiently clean so that further picking and raking will not be required.

B. All stumps, roots, sheeting foundations and planking embedded in the ground shall be removed and disposed of. Stumps and roots larger than 1 inch shall be grubbed and removed to a depth not less than 4 feet below grade. All holes or cavities, which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to the same density as the surrounding material.

C. Surface rocks and boulders shall be grubbed from the soil and removed from the site or used as fill in accordance with Section 02200, Earthwork.

D. Burying of any materials and organics shall not be allowed.

E. The Contractor shall be responsible for all damages to existing improvements resulting from Contractor's operations.

3.03 DISPOSAL OF REFUSE

A. The refuse resulting from the clearing and grubbing operation shall be hauled to a disposal site secured by the Contractor and shall be legally disposed of in accordance with all requirements of federal, state, county and municipal regulations. No refuse of any kind shall be deposited in any stream or body of water, or in any street or alley. In no case shall any material be left on the site, shoved onto abutting private properties, or buried on the Project Site.

3.04 KUDZU REMOVAL

A. The Contractor shall remove and eradicate all kudzu from the construction limits.

B. During the growing season, treat the emerging and existing growth with dicotyledon selective herbicide as per the manufacturer's directions and wait two weeks before starting the clearing and grubbing of the kudzu.

C. Remove the kudzu and roots by mechanical means. Hand clear the remaining roots.

D. Treat emerging growth with dicotyledon selective herbicide as per manufacturer's direction. After two weeks, remove the remaining kudzu.

E. Continue herbicide applications and removal to emerging kudzu as necessary.

F. Do not spill on slopes or other grassed areas. Keep the spray controlled so that it does not enter the waters of the State. Repair vegetated areas damaged by careless handling or overspray of the herbicide at no additional expense to the owner.

END OF SECTION 02110

SECTION 02112
TREE PROTECTION AND SELECTIVE TRIMMING

PART 1 - GENERAL

1.01 SCOPE

A. Tree protection shall be accomplished on all areas to be protected from impact by new construction. Tree protection operations include but are not limited to the following:

1. Tree protection staking of the areas on the site, construction of tree protection fencing, removal of indicated vegetation, protection of existing trees designated to remain, erosion control, underbrush clean-up, and pruning.

1.02 RELATED DOCUMENTS

A. The Drawings and general provisions of the Contract, including General and Special Conditions, apply to work of this section.

1.03 CODES AND STANDARDS

A. In addition to complying with all pertinent codes and regulations, comply with the requirements of those insurance carriers providing coverage for this work.

1.04 QUALITY ASSURANCE

A. Qualification of the Workmen: Provide at least one person who shall be present at all times during tree clearing and grubbing operations and who shall direct the trimming of roots and limbs where required. Provide at least one person who is qualified in the various other trades involved including demolition, protection of property, and erosion control.

1.05 JOB CONDITIONS

1. Dust Control: Use all means necessary to prevent the spread of dust during performance of the work of this section. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the work on the site and surrounding areas.
2. Erosion Control: Install and maintain berms, swales, and bales as required to trap waterborne soil particles. As work progresses, relocate and/or add to erosion control system as necessary and described in Section 02125 Erosion and Sedimentation Control.
3. Protection: Use all means necessary to protect existing objects designated to remain and, in the event of damage, immediately make all repairs and replacements necessary to the approval of the Landscape Architect at no additional cost to the Owner.
4. Tree Protection
5. Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking, or skinning of roots, skinning and bruising of bark, smothering of trees by stockpiling construction materials, or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line.
6. Provide temporary fences, barricades, or guards as required to protect trees and vegetation to be left standing. Contractor shall not store, stack, or place materials of any form under the

drip line of trees to be saved. Equipment such as vehicles shall not be parked under trees or traverse beneath the drip line of trees to be saved.

7. Water trees and other vegetation which are to remain within the limits on the Contract work as required to maintain their health during the course of construction operations.

8. Provide protection for roots over 2-inch diameters that are cut during construction operation. Temporarily cover all exposed roots with wet burlap to prevent from drying out; provide earth cover as soon as possible.

9. Repair or replace trees and vegetation damaged by construction operations, in a manner acceptable to the Landscape Architect. Tree damage repair shall be performed by a qualified tree surgeon. Replace trees which cannot be repaired and restored to full growth status, as determined by the tree surgeon.

10. Protect tree root system from damage due to deleterious materials in solution caused by run-off, or spillage during mixing of construction materials or drainage from stored materials. Protect root system from flooding, erosion, or excessive wetting resulting from de-watering operations.

11. Tree Penalty: The intent of this clause is to emphasize the importance of all trees to be saved. All trees to be saved shall be maintained in an undamaged condition. Damage shall be defined as the act of scarring, nailing, cutting, breaking limbs, etc., of any tree or its root system in such a manner as may cause the tree to be permanently hurt. Accidental damage due to dead trees falling, equipment breakdown, or any act on the part of the operator which appears to the Landscape Architect as unavoidable would not warrant a penalty. However, the Contractor will be liable for consistently damaging trees by accidental damage. Damage due to improper location of utility trenches or ditches will not be considered accidental. The Contractor will be responsible for damage on the part of the operator or operators, whether by method of excavation, use of improper equipment, incompetency of the operator, or failure to properly inform the operator, as determined by the Landscape Architect.

12. All trees on the site shall be saved except those marked specifically to be removed, those within the clearing limits on the plans; and those marked specifically on the site by the Landscape Architect to be removed. No tree, either those marked for removal on the site, or any other tree may be removed from the site prior to the Landscape Architect's inspection. Penalties for damage to or removal of any tree not specifically approved by the Landscape Architect on the site will be as follows:

Large Trees			Small Trees & Evergreen Trees (Dogwoods, Hollies, Wax Myrtles, Magnolias, etc.)	
Caliper(inches)	Height Penalty	Price	Height Penalty(feet)	Price
I 1/2 - 2		135.00	6- 8	130.00
2 - 2 1/2		150.00	8-10	150.00
2 1/2 - 3		180.00	10-12	200.00
3 - 3 1/2		200.00	12-14	250.00
3 1/2 - 4		250.00	14-16	325.00
4 - 4 1/2		300.00	16-18	375.00
4 1/2 - 5		370.00	18- Up	500.00
5-6		475.00	Follow large tree schedule using caliper of trunk	
6-7		600.00		
7-8		650.00		
8 - 11		1,500.00		
12 - 20		2,500.00		
21 - Larger		3,500.00		

13. Root Rakes: No root rake devices shall be used in proximity to trees scheduled to remain.
14. Trees will be graded by the Landscape Architect as to species, condition, and site importance with the above figures acting as maximum penalties with the lowest assessment amounting to no less than one-half of the above penalty figures.
15. Disposal: All materials removed by the clearing operation shall be disposed of off-site. No burning of trees, stumps, or other matter shall be conducted on the site, unless permission is obtained from the Owner.

PART 2 - PRODUCTS

2.01 TEMPORARY BARRICADES

A. Unless otherwise approved by the Landscape Architect, use only new and solid lumber of utility grade or better to construct temporary barricades around trees and areas designated to remain undisturbed.

2.02 EXPLOSIVES

A. Do not use explosives in this work.

2.03 OTHER MATERIALS

A. All other materials not specifically described but required for proper completion of the work of this section, shall be as selected by the Contractor subject to approval of the Landscape Architect.

PART 3 - EXECUTION

3.01 SITE INSPECTION

A. Prior to any work of this section, carefully inspect the entire site and designate all trees to be preserved.

3.02 SCHEDULING

A. Schedule all work in a careful manner with all consideration for neighbors and the general public.

B. Notify the Landscape Architect at least five full working days prior to commencing clearing and tree removal work of this Contract.

3.03 STAKING

A. The Contractor shall stake the protective fence as to location and configuration. This stakeout may be accurate or rough, depending on the Contractor's preference.

B. The purpose of the staking, with inspection and adjustment by the Landscape Architect, is to adjust the areas of the site to allow the contractor maximum use of the land. Staking is subject to various degrees of adaptation which can only be determined by the Landscape Architect. This variation is an aesthetic decision, the amount of adjustment most often determined by the existing trees, terrain, soil conditions, sub-surface water and by other intangibles which are impractical to survey in absolute accuracy.

C. The Contractor shall notify the Landscape Architect at least three working days before inspection of the construction stakeout to coordinate tree protection. During the inspection the Landscape Architect will adjust the stake-out as necessary to fit the trees, topography, and all other objects and conditions on the site. At this time the Landscape Architect will clearly mark all trees and other vegetation to be removed. This staking-inspection process must take place prior to any tree removal, grading, construction, or any other work on the site.

D. During inspection, the general contractor's superintendent shall be at the site along with the foreman who will supervise the work under this Contract.

E. The staking-inspection process shall be repeated for any work not staked and approved or adjusted during the first site visit. No work shall ever be done without the stakeout first being adjusted and approved by the Landscape Architect. All alignments, dimensions, and elevation of any grading, excavation, construction, and planting is subject to adjustment to save trees and other vegetation. Refer to the staking process as described in the Special Conditions.

3.04 TOPSOIL REMOVAL

A. See Section 02200.

B. Where trees are to remain standing, stop topsoil stripping a sufficient distance from such trees to prevent damage to the main root system.

C. Stockpile topsoil in storage piles in areas where directed. Topsoil shall not be stockpiled in tree save areas. Construct storage pile to freely drain surface water. Cover storage pile as necessary to prevent windborne dust and erosion.

3.05 WOODLAND PRUNING AND UNDERBRUSHING

A. Clear the site of brush, rubbish, dead limbs, snags, fallen trees, and any other plant material designated by the Landscape Architect to be removed. No trees shall be removed, or limbs and roots cut without prior approval of Landscape Architect or Owner's Representative.

B. Do not remove stumps in areas to be left natural. Do not use root rakes or track equipment under any trees designated to be saved.

C. Prune remaining trees by removing all low hanging limbs less than six feet above the ground by cutting with a hand saw. Pruning cuts shall be made in accordance with good pruning practices. Pruner shall not cut the cambrium collar. Remove all dead trees, broken trees, leaning trees, and diseased trees. Refuse may be removed from the site or chipped with a chipper and spread under the trees.

D. Underbrush all small sprouts, scrubs, vines, and weeds as defined on-site by Landscape Architect. Landscape Architect shall meet on-site with Contractor to review the requirements and tag trees to be protected.

E. Do not rake up or remove existing leaf or pine nettle mulch on the ground.

3.06 EROSION CONTROL

A. Sow grass as necessary during construction to prevent erosion of disturbed areas and prevent damage to tree save areas from runoff and silt. See Section 02125.

3.07 INTERIM SEEDING AND MAINTENANCE

A. Seed temporarily with appropriate grass seed in the event that Bermuda grass cannot be sown during the specified season.

3.08 SILT CONTROL

A. The Contractor shall install silt barriers in locations necessary to prevent eroded material from silting undisturbed vegetation as shown on the Plans.

END OF SECTION 02112

SECTION 02125
EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 SCOPE

A. The work specified in this Section consists of providing and maintaining temporary and permanent erosion and sedimentation controls as shown on the Drawings. This Section also specifies the subsequent removal of temporary erosion and sedimentation controls.

B. Temporary and permanent erosion and sedimentation controls include grassing and mulching of disturbed areas and structural barriers at those locations that will ensure the erosion during construction will be maintained within acceptable limits. Acceptable limits are as established by the Georgia Erosion and Sedimentation Control Act of 1975, as amended, Section 402 of the Federal Clean Water Act, and applicable codes, ordinances, rules, regulations and laws of local and municipal authorities having jurisdiction.

C. Manual for Erosion and Sediment Control in Georgia and the Field Manual for Erosion and Sediment Control in Georgia by the Georgia Soil and Water Conservation Commission, 4310 Lexington Road, Post Office Box 8024, Athens, Georgia 30603, 706-542-3065, shall be considered part of these contract documents.

D. Land disturbance activity shall not commence until all applicable permits have been issued.

E. The Contractor shall file the NPDES Notice of Intent, Notice of Termination and Comprehensive Monitoring Plan with the state of Georgia.

F. Perform all operations in accordance with applicable provisions for erosion control as shown on the Drawings and as required by local, State and Federal regulations.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. At the Pre-Construction Conference, the Contractor shall submit, for the Engineer's approval, a schedule for the accomplishment of temporary and permanent erosion and sedimentation control work. No work shall be started until the erosion and sedimentation control schedule and methods of operation have been approved by the Engineer.

1.03 QUALITY ASSURANCE

A. The temporary and permanent erosion and sedimentation control measures shown on the Drawings are minimum requirements. Any additional erosion and sedimentation control measures required by the Contractor's means, methods, techniques and sequence of operation will be installed by the Contractor at no additional cost to the Owner.

B. Implementation

1. The Contractor is solely responsible for the control of erosion within the Project site and the prevention of sedimentation from leaving the Project site or entering waterways.
2. The Contractor shall install temporary and permanent erosion and sedimentation controls which will ensure that runoff from the disturbed area of the Project site shall pass through a filter system before exiting the Project site.
3. The Contractor shall provide temporary and permanent erosion and sedimentation control measure to prevent silt and sediment from entering the waterways.
4. The Contractor shall limit land disturbance activities to those areas shown on the Drawings.
5. The Contractor shall maintain erosion and sedimentation control measures within disturbed areas on the entire site at no additional cost to the Owner until the acceptance of the Project. Maintenance shall include mulching, re-seeding, clean-out of sediment barriers and sediment ponds, replacement of washed-out or undermined rip rap and erosion control materials, to the satisfaction of the Engineer.
6. All fines imposed for improper erosion and sedimentation control shall be paid by the Contractor.

PART 2 - PRODUCTS

2.01 GENERAL

A. The materials shall meet the requirements of the Manual for Erosion and Sediment Control in Georgia and the Field Manual for Erosion and Sediment Control in Georgia or the Georgia Department of Transportation Standard Specifications Construction of Transportation Systems.

PART 3 - EXECUTION

3.01 GENERAL

A. Temporary and permanent erosion and sedimentation control measures shall prevent erosion and prevent sediment from exiting the site. If, in the opinion of the Engineer, the Contractor's temporary erosion and sedimentation control measures are inadequate, the Contractor shall provide additional maintenance for existing measures or additional devices to control erosion and sedimentation on the site at no additional cost to the Owner.

B. All erosion and sedimentation control devices and structures shall be inspected by the Contractor at least once a week and immediately prior to each rainfall occurrence. Any device or structure found to be damaged will be repaired or replaced by the end of the day.

C. Provide erosion and sediment control as follows:

1. Continuously coordinate the erosion and sediment control with the clearing and construction activity.
2. All cut and fill banks shall be top soiled and seeded within 3 weeks of their completion. Intermediate and temporary seeding shall be at the Contractor's expense.
3. Retain natural vegetation whenever feasible.

4. Restore and cover exposed areas subject to erosion as quickly as possible by means of seeding and mulching. Use diversion ditches and/or other methods as appropriate to prevent storm water from running over the exposed area until seeding is established as specified.

5. Mechanically retard the rate of runoff water with baled erosion checks anchored to the ground with two stakes per bale. Maintain the checks replacing broken or damaged bales and clean out trapped debris.

6. Trap the sediment contained in the runoff water with silt fences. Maintain the silt fence for the project duration and remove silt accumulation. Place sediment basins if necessary to meet governmental regulations.

7. Install baled erosion checks or silt fences where existing ground slopes toward or away from disturbed areas along the top or toe of slopes, along streams, in ditches, or other areas where siltation, erosion, or water runoff is a problem.

8. Divert water from erosive areas.

9. Control dust by sprinkling or other means as necessary to keep it to a minimum.

D. Re-grade and reseed surfaces eroded or otherwise damaged during any and all construction operations as necessary.

E. All erosion and sedimentation control measures and devices shall be constructed and maintained as indicated on the Drawings or specified herein until adequate permanent disturbed area stabilization has been provided and accepted by the Engineer. Once adequate permanent stabilization has been provided and accepted by the Engineer, all temporary erosion and sedimentation control structures and devices shall be removed.

3.02 CLEAN-UP

A. Upon completion of the work of this Section, remove all rubbish, trash and debris resulting from construction operations. Remove surplus equipment and tools. Leave the site in a neat and orderly condition acceptable to the Engineer, and in conformance with the General Conditions of the Contract Documents.

END OF SECTION 02125

SECTION 02140
DEWATERING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, equipment, tools and incidentals required for all dewatering. This work includes the installation, operation, and removal of all facilities required to maintain open excavations and trenches in a dewatered condition to permit unrestricted construction operations.

B. Construct all permanent work in areas free from water. Design, construct and maintain all pumping systems, dikes, levees, cofferdams, diversion and drainage channels as necessary to maintain the areas free from water and to protect the areas to be occupied by permanent work from water damage. Remove temporary works after they have served their purpose.

C. The Contractor shall be responsible for the stability of all temporary and permanent slopes, trenches, grades, foundations, materials and structures during the course of the Contract. Repair and replace all slopes, grades, foundations, materials and structures damaged by water, both surface and sub-surface, to the lines, grades and conditions existing prior to the damage at no additional cost to the Owner.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents and as specified hereinafter.

B. Working Drawings

1. Submit complete working drawings and supporting documents showing the type of water control system proposed for each site where required. Obtain Engineer's approval prior to installation of the system.
2. Working Drawings and supporting documents will show:
   a. Arrangement and location of the system.
   b. Complete description of equipment and materials to be used.
   c. Installation and operation and maintenance procedures.
   d. Design calculations.
   e. Standby equipment and power supply.
   f. Location and size of berms, dikes, settling basins, sumps, and discharge items.
   g. Pollution control facilities.
   h. Discharge locations.
   i. Number and location of monitoring wells.
3. Working Drawings and supporting documents will be revised and resubmitted if the system is modified during installation or during operation.

C. Copies of all permits required to discharge the water as specified below.

1.03 JOB CONDITIONS

A. Permits: Prior to discharging water into a storm sewer or waterway, obtain all necessary permits from the jurisdictional agencies and submit a Notice of Intent to the Georgia Environmental Protection Division by certified return receipt mail at least 48 hours prior to conducting any land disturbance activities.

B. Responsibilities

1. Select and install a system to control water as herein specified, and to comply with the requirements of the jurisdictional agencies.
2. Take measures to prevent damage to properties, buildings or structures, sewers and other utility installations, pavements, sidewalks, improvements and work.
3. Do not overload or obstruct existing facilities.
4. Modify the system at no additional cost to the Owner if after installation and while in operation it causes or threatens to cause damage to existing buildings, structures, utilities, facilities, or other adjoining property.
5. Monitor the quality of the discharge from the dewatering system, as required, to meet requirements from jurisdictional agencies.
6. Measure and evaluate if movements are being caused to adjacent buildings, structures, utilities, facilities or other adjoining properties by dewatering operations.
7. Repair damage, disruption, or interference resulting directly or indirectly from dewatering operations at no additional cost to the Owner and to the Engineer's approval.
8. Restore, maintain and monitor on a weekly basis all existing piezometric observation wells located within or on the Project site. Additional piezometric observation wells shall be required to monitor the ground water level, to ensure proper dewatering prior to excavation below the static water table. The number of wells required will vary to meet the Contractor's responsibilities and will depend on the size and depth of the excavations required for the work to be constructed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CARE OF WATER

A. Except where the excavated materials are designated as materials for permanent work, material from required excavation may be used for dikes, levees, cofferdams and other temporary backfill.

B. Furnish, install, maintain and operate necessary pumping and other equipment for dewatering the various parts of the work and for maintaining the foundation and other parts free from water as required for constructing each part of the work.

C. Install all drainage ditches, sumps and pumps to control excessive seepage on excavated slopes, to drain isolated zones with perched water tables, and to drain impervious surfaces at final excavation elevation.

D. After they have served their purpose, remove all temporary protective work at a satisfactory time and in a satisfactory manner. All diversion channels and other temporary excavations in areas where the compacted fill or other structures will be constructed shall be cleaned out, backfilled and processed under the same Specifications as those governing the compacted fill.

E. When the temporary works will not adversely affect any item of permanent work or the planned usage of the Project, the Contractor may be permitted to leave such temporary works in place. In such instances breeching of dikes, levees and cofferdams may be required and grout filling of all wells. Otherwise the temporary works and all debris shall be completely removed and the site restored to its original condition.

F. Intercept and divert surface drainage away from the excavation, by the use of dikes, curb walls, ditches, pipes, sumps, or other means.

G. Design surface drainage systems so that they do not cause erosion on or off the site or cause unwanted flow of water.

3.02 DEWATERING

A. By the use of well points, pumps, tile drains or other approved methods, the Contractor shall prevent the accumulation of water in excavated areas. Should water accumulate, it shall be promptly removed.

B. Excavations shall be continuously dewatered to maintain a ground water level no higher than three feet below the lowest point in the excavation unless otherwise specified. Dewatering systems shall be designed to allow for localized variations in the depth of excavations required to reach a suitable foundation. Dewatering shall be accomplished well enough in advance of excavation to ensure that groundwater is already lowered prior to completing the final excavation to finish subgrade.

C. Piezometric observation wells shall be required, to monitor the ground water level, to ensure proper dewatering prior to excavation below the static water table. The number of wells required will vary depending on the size and depth of structures.

D. No separate payment will be made for dewatering required to accomplish the work. The cost for such shall be considered incidental to the work for which it is required.

E. Provide and maintain ditches of adequate size to collect surface water and seepage which may enter the excavations and divert the water into a sump so that it can be drained or pumped into drainage channels and settling basins prior to discharge to storm sewers if approved by the Engineer and the jurisdictional agency concerned.

F. Dewater by means which will ensure dry excavations, preserve final lines and grades, and not disturb or displace adjacent soil.

G. All destabilized subgrade conditions caused by inadequate or untimely dewatering operations shall be undercut and backfilled with suitable backfill material at no additional cost to the City.

H. Should a storm sewer become blocked or have its capacity restricted due to the dewatering operations, make arrangements with the jurisdictional agency for the cleaning of the sewer and appurtenances at no additional expense to the City.

END OF SECTION 02140

SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes earthwork and related operations, including, but not limited to; excavating all classes of material encountered; trenching; handling; storage; transportation; and disposal of all excavated and unsuitable material; construction of fills and embankments; backfilling around structures and pipe; backfilling all trenches and pits; compacting; all sheeting; shoring and bracing; preparation of subgrades; surfacing and grading; and any other similar, incidental, or appurtenant earthwork operation which may be necessary to properly complete the Work.

B. The Contractor shall provide all services, labor, materials, and equipment required for all earthwork and related operations necessary or convenient to the Contractor for furnishing complete Work as shown on the Drawings or specified in these Contract Documents.

1.02 GENERAL

A. Safety: Comply with local regulations and with the provisions of the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc., Occupational Safety and Health Act (OSHA) and all other applicable safety regulations.

B. The elevations shown on the Drawings as existing are taken from the best available data and are intended to give reasonable information about the existing elevations. The Contractor shall verify conditions to determine the exact quantities of excavation and fill required.

C. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards.

D. All excavated and filled areas for structures, trenches, fills, topsoil areas, embankments and channels shall be maintained by the Contractor in good condition at all times until final acceptance by the City. All damage caused by erosion or other construction operations shall be repaired by the Contractor using material of the same type as the damaged material at no cost to the City.

E. The Contractor shall control grading in a manner to prevent water running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm water can flow uninterrupted in existing open ditches or channels; other surface drains; or temporary drains.

F. No classification of excavated materials will be made except as noted below. Excavation work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the Work, regardless of the type, character, composition or condition thereof. All excavating shall be unclassified except to determine if material is contaminated and requires hauling to landfill.

G. Soil testing will be performed by an independent testing laboratory in accordance with GC-30 and Section 01410. The Contractor shall make all necessary excavations and shall supply any samples of materials necessary for conducting compaction and density tests. The cost of all

retests made necessary by the failure of materials supplied by the Contractor, his agents or subcontractors, to conform to the requirements of these Contract Documents shall be paid by the Contractor. Contractor shall provide at least 24 hours advance notice of earthwork operations to the Testing Laboratory. Testing Laboratory shall provide periodic reports, at least monthly during the earthwork operations, to the Engineer with copies to the Contractor certifying (and sealed by a Registered Georgia Engineer) that earthwork is in conformance with the plans and specifications. As a minimum at least one density test shall be performed for every 5,000 square feet of fill area and every two feet of fill lift. The Testing laboratory shall witness the placement of all fill, unless otherwise directed by the Engineer.

H. Special testing as directed by the Engineer shall be in addition to that specified in the preceding paragraph and will include testing for contamination of soil and groundwater. Special testing will be performed by an independent testing laboratory in accordance with GC-30 and Section 01410. The Contractor shall make all any samples of materials accessible to the testing personnel as necessary for conducting tests. Contractor shall provide at least 24 hours advance notice of earthwork operations to the Testing Laboratory. Testing Laboratory shall provide immediate results of each special test performed and shall provide daily reports of test results to the Engineer with copies to the Contractor. It is anticipated a minimum of at least one soil test for lead contamination shall be performed for every 10 square yards of excavated material until excavation reaches residual material. It is anticipated a minimum of one daily test for groundwater contamination shall be performed until consistent results are observed that indicate no further testing is necessary, as determined by the Engineer. Payment shall be as an allowance item as described in section 01200 for "Additional Testing".

I. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, Excavations, Trenching, and Shoring, and Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations, and shall be conducted in a manner acceptable to the Engineer.

J. Stockpile Areas: Provided there is space available, stockpiling material may be on site.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Copies of permits obtained by the Contractor for the work.
2. Test results, certification of compliance, source and samples for all imported materials.
3. Samples of fill materials to be used. Samples shall be submitted 2 weeks in advance of use and shall consist of 0.5 cubic feet of each type of material.

1.04 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements, including the partial listing below:

1. ASTM C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D1556, Test Method for Density of Soils in Place by the Sand Cone Method.

3. ASTM D1557, Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb. (4.5-kg) Rammer and 18-in. (457-mm Drop).
4. ASTM D3107, Test Method for Moisture Content of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

PART 2 - PRODUCTS

2.01 MATERIALS

A. Earthwork Materials

1. Controlled Fill:
   a. Proposed fill soils shall be laboratory tested prior to construction use to determine their suitability. All fill material shall be subject to the approval of the Engineer.
   b. Notification: For approval of imported fill material, notify the Engineer and Testing Laboratory at least three (3) weeks in advance of intention to import material, designate the proposed borrow area, and permit the Testing Laboratory to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material. Test results shall be submitted to the Engineer for approval. All fill shall be free of organic matter or debris, have a low to moderate plasticity, (PI<15) uniform composition, and be free of rock fragments greater than three inches in dimension. Soils selected for use as fill material shall also have a standard Proctor (ASTM D 698) maximum dry density of at least 95 pounds per cubic foot.
   c. All on-site fill material shall be soil exclusive of organic matter, frozen lumps or other deleterious substances.
   d. It shall contain no rocks or earth clumps over 3-inches maximum in dimension.
2. Structural Fill and Structural Backfill:
   a. Select on site materials may be suitable. Testing and recommendation of suitability shall be made by the Testing Laboratory and submitted by the Contractor to the Engineer for approval.
   b. Imported material shall be sand, uniformly graded crushed rock or other select material recommended by the Testing Laboratory and submitted by the Contractor to the Engineer for approval. Graded aggregate base material as specified in the Georgia Department of Transportation Standard Specifications is acceptable for structural fill and backfill.
   c. Crushed Rock: Crushed rock used for pipe bedding and drainage stone shall conform to the Georgia Department of Transportation Standard Specifications for construction of Road and Bridges, 800.01 for No. 57 Stone.
3. Coarse Aggregate: Coarse aggregate shall conform to the Georgia Department of Transportation Standard Specifications of Transportation Systems construction of Road and Bridges, 800 for No. 57 Stone, Group II, and shall have the following gradation:

Sieve size	Percent Passing	
1-½ inch	100	-
1 inch	95	100
½ inch	25	60
#4	0	10
#8	0	5

4. Top Soil: Dark organic weed free loam.

B. Sheeting, Bracing and Timbering: The Contractor shall furnish, place and maintain all sheeting, bracing and timbering required to properly support trenches and other excavations in open cut and to prevent all movement of the soil, pavement, structures, or utilities outside of the trench or pit.

1. General:
   a. All sheeting, bracing and timbering shall be designed by a registered Professional Engineer in the State of Georgia at the Contractor's expense. Submit a copy of the design to the Engineer for the Project files.
   b. Sheeting, bracing and timbering shall be so placed as to allow the Work to be constructed to the lines and grades shown on the Drawings.
   c. If at any time the method being used by the Contractor for supporting any material or structure in or adjacent to any excavation is not reasonably safe the Engineer may require and the Contractor shall provide additional bracing and support necessary to furnish the added degree of safety. The Contractor shall provide such added bracing and support by such method as Contractor may elect to use, but the taking of such added precautions shall in no way relieve the Contractor of sole and final responsibility for the safety of lives, work and structures.
   d. All sheeting and shoring in contact with the concrete or masonry shall remain in place. The sheeting or shoring above the structure may remain in place or be cut off. No sheeting shall be left in place within three feet below the ground surface.
   e. There shall be no payment for sheeting, bracing, and timbering left in place.
2. Timber:
   a. Timber may be substituted for steel sheet piling when approved by the Engineer. Timber for shoring, sheeting or bracing shall be sound and free of large or loose knots and in good condition. Size and spacing shall be in accordance with OSHA regulations.
   b. Remove bracing and sheeting in units when backfill reaches the point necessary to protect the work and adjacent property. Leave sheeting in place when it cannot be safely removed. Cut off sheeting left in place below the finished ground surface by three feet.
3. Steel Sheet Piling: Steel sheet piling shall be the continuous interlock type. The weight, depth and section modulus of the sheet piling shall be sufficient to restrain the loads of earth pressure and surcharge from existing foundations. Procedure for installation and bracing shall be so scheduled and coordinated with the removal of the earth that the ground under existing structures shall be protected against lateral or vertical movement at all times. In addition to the Drawings and computations, the Contractor shall provide closure and sealing details between sheet piling and existing facilities, as well as method of excavation within sheet piling to the Engineer for review before commencing construction operations. Contractor shall be responsible for all damage to existing utilities and structures resulting

from installation of sheet piling. Damage to existing utilities and/or structures resulting from installation of sheet piling shall be repaired at the Contractor's expense.

C. Other Materials: All other materials not specifically described but required for proper completion of the work of this Section, shall be as selected by the Contractor subject to the prior approval of the Engineer.

PART 3 - EXECUTION

3.01 GENERAL

A. Benching of Slopes: When the embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when the embankment is to be built ½ width at a time, the slopes that are steeper than 4:1 as measured at right angles to the embankment shall be continuously benched over those areas as the work is brought up in layers. Benching shall be of sufficient width to permit the operation of placing and compacting equipment. Each successive cut shall begin at the intersection of the original ground and the vertical side of the previous cut. Material thus cut shall be recompacted along with the new embankment material. Proofroll subgrade prior to placement of fill material.

B. Topsoil

1. Remove all topsoil to a depth at which subsoil is encountered, from all areas, which are to be cut to lower grades or filled.
2. Topsoil to be used for finish grading may be stored on the site. It shall be piled properly, sloped to drain and covered.

C. Bracing and Sheeting

1. Furnish, install, and maintain all sheeting, bracing, and shoring as may be required to properly support the sides of all excavations and to prevent all movement of earth, which could in any way injure the work, adjacent property, or workmen.
2. Properly support all trenches for piping and duct bank installation so as to conform to all pertinent rules and regulations and these Specifications. All trenches deeper than 5 feet shall be shored unless cut to the angle of repose of the excavated soils.
3. Exercise care in the removal of sheeting, shoring, bracing and timbering to prevent collapse or caving of the excavation faces being supported and damage to the work and adjacent property.
4. Do not leave any sheeting or bracing in the trench or excavation after completion of the work, unless approved or instructed by the Engineer. The cost of leaving sheeting or bracing shall be at the Contractor's expense.
5. All sheeting and shoring in contact with concrete or masonry shall remain in place. The sheeting and shoring above the structure may remain or be cut off. No sheeting or shoring left in place shall be within three feet below the ground surface.

D. Obstructions

1. Remove and dispose of all trees, stumps, roots, boulders, pavement, pipes and the like, as required for the performance of the work.
2. Exercise care in excavating around catch basins, inlets, manholes, piping, duct banks, underground vaults, etc.
3. Avoid removing or loosening castings or pushing dirt into structures.
4. Damaged or displaced casting shall be repaired and replaced, and dirt entering the structures during the performance of the work shall be removed at no additional cost to the City.

E. Utilities to be Abandoned:

1. When pipes, conduits, sewers or other structures are removed from the trench leaving dead ends in the ground, such ends shall be fully plugged and sealed.
2. Abandoned structures such as manholes, catch basins or chambers shall be entirely removed unless otherwise specified or indicated on the Drawings.

F. Extra Earth Excavation: In case soft material, which, in the opinion of the Engineer is not suitable, is encountered in the bottom of a trench or underneath a structure, the soft material shall be removed to a minimum depth of six (6) inches and replaced with structural fill or gravel.

G. Cutting Paved Surfaces and Similar Improvements:

1. Remove existing pavement as necessary for installing pipe utilities and appurtenances or as otherwise shown on the Drawings.
2. Before removing any pavement, mark the pavement neatly, paralleling pipe lines and existing street lines. Space the marks to match the width of the trench.
3. Break asphalt pavement along the marks using jack hammers or other suitable tools. Break concrete pavement along the marks by use of jack hammers or by scoring with a rotary saw and breaking below the score by the use of jack hammers or other suitable tools.
4. Do not pull pavement with machines until completely broken and separated from pavement to remain.
5. Do not disturb or damage the adjacent pavement. If the adjacent pavement is disturbed or damaged, remove and replace the damaged pavement. Refer to Section 02510 for replacement of damaged or removed pavement.
   a. NOTE: No additional payment will be made for removing and replacing damaged adjacent pavement.
6. Remove and replace sidewalks disturbed by construction for their full width and to the nearest undisturbed joint.
7. The Contractor may tunnel under curbs that are encountered. Remove and replace any curb disturbed by construction to the nearest undisturbed joint.

3.02 EXCAVATION

A. General

1. All excavations for pipe appurtenances and structures shall be made in such manner and to such depth and width as will give ample room for building the structures and for bracing, sheeting, and supporting the sides of the excavation, for pumping and draining groundwater and wastewater which may be encountered, and for the removal from the trench of all materials excavated.

2. Water shall not be allowed to accumulate in excavations. Contractor shall provide sufficient temporary pumping to assure that surface and ground waters do not saturate foundation soils.

B. Grades

1. Excavate to lines and grades indicated on the Drawings.

2. Where excavation grades are not indicated on the Drawings, excavate as required to accommodate installation.

C. Disposal of Excavated Material

1. Remove and legally dispose of all excavated material not needed to complete filling, backfilling, and grading.

2. Dispose of excess excavated material at locations secured by the Contractor and in accordance with all requirements of federal, state, county and municipal regulations. No debris of any kind shall be deposited in any stream or body of water, or on any street or alley. No debris shall be deposited on any private property except by written consent of the property owner. In no case shall any material be left on the Project, or be buried in embankments or trenches on the Project. With recommendation of the Testing Laboratory and approval by the Engineer, demolished, crushed concrete may be acceptable for use in fill areas.

3. Excavated materials shall be placed adjacent to the work to be used for backfilling as required.

4. Excavated materials shall be placed sufficiently back from the edge of the excavation to prevent caving of the trench wall, to permit safe access along the trench and to not cause any drainage problem. Excavated material shall be placed so as to not damage existing landscape or man-made improvements. Surcharging of any bank is not allowed.

D. Rock Excavation

1. Rock excavation shall be paid for as unclassified excavation.

2. Rock excavation shall mean rock requiring blasting and shall be such material which cannot be removed with a crawler tractor equal to a D-8 Caterpillar, equipped with a single-tooth ripper or by an excavator trackhoe equal to a Caterpillar 225 rated with a ¾ cubic yard capacity with a bucket curling pullout capacity of 25,000 pounds.

3.03 EXCAVATING FOR STRUCTURES

A. Dewatering

1. The proposed dewatering plan shall be submitted by the Contractor to the Engineer for approval at least ten (10) working days prior to the beginning of any excavation.
2. Furnish, install, maintain and operate necessary pumping and other equipment for dewatering the various parts of the Work and for maintaining the foundation and other parts free from water as required for constructing each part of the Work.
3. By the use of well points, pumps, tile drains or other approved methods, the Contractor shall prevent the accumulation of water in excavated areas. Should water accumulate, it shall be promptly removed.
4. Excavations shall be continuously dewatered to maintain a ground water level no higher than 3 feet below the lowest point in the excavation.
5. Piezometric observation wells shall be required, to monitor the ground water level, to ensure proper dewatering prior to excavation below the static water table. The number of wells required will vary depending on the size and depth of structures and shall be included in the plan.
6. The cost for all dewatering and discharge shall be at the Contractor's expense and shall be considered incidental.

B. Excavation

1. All excavation is unclassified and shall be included in the Lump Sum portion of the Contractor's Base Bid.
2. Excavation shall include all substances to be excavated. Excavation for structures shall be to limits not less than 2 feet outside wall lines, to allow for formwork and inspection.
3. Where rock excavation is carried below grade the Contractor shall backfill to grade using concrete or structural fill.
4. Where unsuitable material is encountered excavate material to a depth acceptable to the Engineer and fill with compacted structural fill as required.

C. Construction Observations: All excavations should be examined by the Engineer prior to reinforcing steel placement to verify that the design bearing pressure is available. All excavations should be clean, level and free of ponded water, mud and loose, frozen or water-softened soils. If it is necessary for an excavation to remain open overnight, or if rain is imminent, a 3-to 4-inch thick "mud mat" of Class B concrete may be placed in the bottom of the excavation to protect the bearing soils until reinforcing steel and concrete can be placed.

D. Unsuitable Bearing: If unsuitable bearing for foundations is encountered at the elevations indicated on the Drawings, the Engineer shall be notified immediately.

3.04 TRENCH EXCAVATION

A. Excavation for trenches shall include the removal of all material of any nature for the installation of the pipe or facility and shall include the construction of trench shoring and stabilization measures, timbering and all necessary installations for dewatering.

B. Minimum Width of Trench. The minimum width of pipe trenches, measured at the crown of the pipe, shall not be less than 24-inches greater than the exterior diameter of the pipe, exclusive of bells. The minimum base width, measured at the invert of the piping, of such trench shall be not less than 24-inches greater than the exterior diameter of the pipe, exclusive of special structures or connections, and such minimum width shall be exclusive of all trench supports.

C. Maximum Width of Trench. The maximum allowable width of trench for all pipelines measured at the top of the pipe shall be the outside diameter of the pipe (exclusive of bells or collars) plus 24-inches, and such maximum shall be inclusive of all timbers and/or trench boxes, shoring, etc. A trench wider than the outside diameter plus 24-inches may be used without special bedding if the Contractor, at his expense will furnish pipe of the required strength to carry the additional trench load. Such modifications shall be submitted to the Engineer and approved in writing. Whenever such maximum allowable width of trench is exceeded for any reason, except as provided for on the Drawings or in the Specifications or by the written instruction of the Engineer, the Engineer may require that the Contractor, at the Contractor's expense for all labor and materials, cradle the pipe in concrete, or other approved pipe bedding.

D. Maximum length of Open Trench. Except by special permission by the Engineer, only that amount of pipe construction will be permitted, including excavation, construction of pipeline, and backfill in any one location, which can be completed in one day; however, maximum length of open trench shall never exceed 100 feet. This length includes open excavation, pipe laying and appurtenant construction and backfill which have not been temporarily resurfaced.

E. Trench Side Slopes

1. Temporary trench excavations shall at all times conform to the safety requirements of OSHA.
2. Loose cobbles or boulders shall be removed from the sides of the trenches before allowing workmen into the excavation, or the trench slopes must be protected with screening or other methods. Trench side slopes shall be kept moist during construction to prevent local sloughing and raveling. Surcharge loads due to construction equipment shall not be permitted within 5 feet of the top of any excavated slope.

F. Trench Rock Excavation

1. Definition of Trench Rock: Any material which cannot be excavated with conventional excavating equipment, and is removed by drilling and blasting, and occupies an original volume of at least one-half cubic yard.
2. Blasting: Provide licensed, experienced workmen to perform blasting. Conduct blasting operations in accordance with all existing ordinances and regulations. Protect all buildings and structures from the effects of the blast. Repair any resulting damage. If the Contractor repeatedly uses excessive blasting charges or blasts in an unsafe or improper manner, the Engineer may direct the Contractor to employ an independent blasting consultant to supervise the preparation for each blast and approve the quantity of each charge.

3. Removal of Rock: Dispose of rock off site that is surplus or not suitable for use as rip rap or backfill.

4. The Contractor shall notify the Engineer prior to any blasting. Additionally, the Contractor shall notify the Engineer before any charge is set.

5. Blast monitoring shall be performed by the Contractor. The purpose of the blast monitoring is to ensure that the blasting activities produce acceptable results with regard to noise, overpressure and peak particle velocity.

3.05 EXCAVATION BELOW GRADE AND REFILL

A. If the bottom of any excavation is taken out below the limits shown on the Drawings or specified, it shall be refilled to the bottom grade, at the Contractor's expense, except where rock or unsuitable soil is encountered. The refill shall be 6-inch layers of structural fill or other material satisfactory to the Engineer. The type of material to be used shall be the Engineer's option.

3.06 BACKFILL AND FILL PLACEMENT

A. Compaction of fill shall be accomplished by placing the fill material in horizontal lifts of eight-inches (8") maximum loose thickness and mechanically compacting each lift to at least the specified dry density.

B. All fill placement shall be witnessed by an experienced soils technician of the Testing Laboratory and fill density and moisture tests for each lift shall be performed to verify that the specified degree of compaction is being achieved.

C. Prior to placement of any material in embankments, the area within embankment limits shall be stripped of topsoil and all unsuitable materials removed as described under Excavation. Area to receive fill shall then be scarified to a depth of at least 6-inches.

D. The fill shall be brought to the proposed elevation by placing and compacting only approved fill materials upon a subgrade approved by the Engineer.

E. Fill materials shall be placed in continuous approximately horizontal layers extending the full width of the embankment cross-section and the full dimension of the excavation where practicable.

F. The fill shall be placed at a moisture content that corresponds to a +/-3% of the optimum moisture content, as determined by the standard Proctor moisture-density relationship test.

G. Compaction

1. The fill shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil.

2. The upper twelve-inches (12") of fill beneath the structures and pavement areas shall be compacted to 98% of the standard Proctor maximum dry density.

3. Scarification and re-compaction of the upper fill soils immediately prior to the slab-on-grade and/or pavement construction shall be required.

4. Compaction of embankments shall be determined by the Contractor. Placement and compaction of materials shall extend beyond the final contours sufficiently to ensure

compaction of the material at the resulting final surface. Final contours shall then be achieved by a tracked bulldozer or grader shaping the face of the embankment.

5. The backfill placement in trenches and behind structures shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil. Compaction within four (4) horizontal feet of structures must be performed with portable compaction equipment and where confined areas require portable compaction equipment, the fill material shall be placed in horizontal lifts of four-inches (4") maximum loose thickness.

6. If tests indicate that density of backfill is less than that specified, the area shall either be recompacted or undercut, filled, and compacted until specified density is achieved.

H. Final Grading: Upon completion of construction operations, the area shall be graded to finish contour elevations and grades shown on the Drawings. Graded areas shall be made to blend with remaining ground surfaces. All surfaces shall be left smooth and free to drain.

I. Moisture

1. If fill material is too wet, provide and operate approved means to assist the drying of the fill until suitable for compaction.

2. If fill material is too dry, provide and operate approved means to add moisture to the fill layers.

J. Proofrolling

1. All areas where pavement or structures are to be built on compacted fill and other areas where indicated on the Drawing, shall be proofrolled to detect soft spots prior to the placement of fill material or construction of foundations.

2. Proofrolling shall consist of the moving a 20-30 ton loaded dump truck or pneumatic tire roller over the subgrade after the subgrade is shaped. Proofrolling shall be witnessed by the Engineer.

3. Pneumatic-tired rollers shall have not fewer than four pneumatic tired wheels which shall be of such size and ply that tire pressures can be maintained between 80 and 100 pounds per square inch for 25,000 pound wheel load during rolling operations. Unless otherwise required, rolling shall be done with tires inflated to 90 psi. The roller wheels shall be located abreast in a rigid steel frame. Each wheel shall be loaded with an individual weight box so that each wheel will bear an equal load when traversing uneven ground. The weight boxes shall be suitable for ballast loading such that the load per wheel shall be 25,000 pounds. The spacing of the wheels shall ensure that the distance between the nearest edges of adjacent tires shall be not greater than one-half of the tire

4. width of a single tire at the operating pressure for a 25,000 pound wheel load. The roller shall be operated not faster than 5 feet/second.

5. Subgrade shall be proofrolled with 6 passes. Depressions that develop during the proofrolling operation shall be filled with suitable material and those filled areas shall be proofrolled with 6 passes. If, after having been filled and proofrolled, the subgrade still contains depressions, the soil shall be undercut to the full depth of the soft material or 5 feet whichever is less, backfilled, and rolled to achieve a compacted subgrade.

6. After the proofrolled subgrade has been accepted by the Engineer, the surface of the subgrade shall be finish rolled with a smooth steel wheel roller weighing not less than 10 tons. Finished surface of the subgrade shall be within a tolerance of 0.04 feet at every point.

7. Conduits, pipes, culverts and underdrains shall be neither disturbed nor damaged by proofrolling operations. Rollers shall neither pass over, nor approach closer than 5 feet to conduits, pipes, culverts and underdrains unless the tops of those facilities are deeper than 3 feet.

K. During wet or rainy periods, aeration (drying) shall be required to reduce the fill materials to the required moisture condition. During dry periods, water shall be added to achieve the proper moisture content for compaction. Silty soils, which are wet, shall require aeration prior to compaction even during dry periods.

3.07 PIPE BEDDING

A. The Contractor shall excavate to a minimum of 6-inches below the bells or couplings for the full width of the trench and shall place a minimum of 6-inches of No. 57 crushed stone bedding upon which the pipe is to be laid. In cases as determined by the Engineer, where trench material is suitable for use as bedding, the trench may be excavated to a point above the invert grade, and the trench bottom hand shaped so that the bottom segment of the pipe is firmly supported on undisturbed material.

B. Gravity Sewers and Accessories: Lay all pipe with Class "B" bedding, unless shown or specified otherwise:

1. Class "A" (Bedding Factor: 2.8): Excavate the bottom of the trench flat at a minimum depth as shown on the Drawings, below the bottom of the pipe barrel. Place and compact bedding material to the proper grade. Haunching material shall then be carefully placed by hand and compacted to provide full support under around, and up to 4 inches above the top of the pipe

2. Class "B" (Bedding Factor: 1.9): Excavate the bottom of the trench flat at a minimum depth as shown on the Drawings, below the bottom of the pipe barrel. Place and compact bedding material to the proper grade. Haunching material shall then be carefully placed by hand and compacted to provide full support under and up to the centerline of the pipe.

3. Class "C" (Bedding Factor: 1.5): Excavate the bottom of the trench flat at a minimum depth as shown on the Drawings, below the bottom of the pipe barrel. Place and compact bedding material to the proper grade. Haunching material shall then be carefully placed by hand and compacted to provide full support under and up to a height of one-fourth the outside diameter of the pipe above the bottom of the pipe barrel.

C. Manholes: Excavate to a minimum of 12-inches below the planned elevation of the base of the manhole. Place and compact crushed stone bedding material to the required grade before constructing the manhole.

D. Water Mains: Bedding shall meet the requirements for Gravity Sewers, Class B Pipe Bedding regardless of type of pipe material used.

E. At pipe subgrade, if foundation soil in trench is soft, wet, spongy, unstable or does not afford solid foundation for pipe, the Contractor shall excavate as instructed by Engineer and provide stable base for placement of pipe bedding.

F. Where rock is encountered in the trench, the Contractor shall excavate to a minimum 12-inch depth below subgrade and shall construct a base by placing crushed rock upon which a subgrade can be prepared, or as recommended by the pipe manufacturer.

G. Before any pipe is lowered in place, the trench bottom or bedding shall be prepared so that each pipe will have a firm and uniform bearing over the entire length of the barrel and a width equal to one-half the outside diameter of the pipe. All adjustments in line and grade shall be made by scraping away or filling and tamping in under the barrel of the pipe. Wedging or blocking is not permitted.

3.08 TRENCH BACKFILLING

A. Backfilling Pipe Zone. Selected backfill material for the pipe zone shall consist of hereinbefore specified material or native or imported granular material as approved by Engineer in advance of placement. Place material in the trench simultaneously on each side of the pipe for the full width of the trench and the depth of the pipe zone in layers 6-inches in depth. Each layer shall be thoroughly compacted by tamping. In all cases, backfilling of the pipe zone must be done by hand. Particular attention shall be given to underside of the pipe and fittings to provide a firm support along the full length of the pipe. The pipe zone shall be considered to extend 12-inches above the top of the pipe, and shall be compacted to a compaction of not less than 95 percent of maximum standard dry density at optimum moisture content as herein specified. Care shall be taken not to damage pipe or special coatings on the pipe.

B. Backfilling Pipe Trench. After the pipe has been laid in the trench and has been inspected and approved, and backfilling in the pipe zone is complete and compacted, the remainder of the trench may be backfilled. The backfill material shall be suitable material as hereinbefore specified. Care shall be taken to ensure that no voids remain under, around or near the pipes.

C. The backfill placement in trenches and behind structures shall be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D 698) of the fill soil. In confined areas requiring portable compaction equipment the fill material shall be placed in horizontal lifts of four inches (4") maximum loose thickness.

D. Placement and Compaction of Trench Backfill. The placement and compaction of all trench backfill shall conform to one of the following methods subject to the qualification specified therein: Mechanically Compacted Backfill. Backfill may be mechanically compacted by means of tamping rollers, sheepsfoot rollers, pneumatic tire rollers, vibrating rollers, or other mechanical tampers to a minimum of 95 percent standard Proctor at optimum moisture. Trench backfill compaction above the pipe zone shall be to a minimum 98 percent standard Proctor in areas under buildings and pavements. Impact-type pavement breakers (stompers) will not be permitted over any pipe. Mechanically compacted backfill shall be placed in horizontal layers not exceeding the maximum thickness of 8 inches. Each layer shall be evenly spread, the moisture content brought to near optimum condition and then tamped or rolled until the specified compaction and moisture content has been attained. The Contractor shall be responsible for any damage to the pipe and shall replace damaged pipe at his expense.

3.09 BACKFILLING AROUND STRUCTURES

A. General

1. Remove debris from excavations before backfilling.
2. Do not backfill against foundation walls until so instructed by the Engineer
3. Wherever possible, backfilling shall be simultaneous on both sides of walls to equalize lateral pressures.
4. Do not backfill on only one (1) side of vertically spanning walls unless walls are adequately shored or permanent construction is in place to furnish lateral support on both top and bottom of wall.

3.10 GRADING

A. General

1. Perform all rough and finish grading required to attain the elevations indicated on the Drawings.
2. Perform rough grading to an accuracy of plus or minus 0.10 feet.

B. Grading Around Buildings: Control the grading around buildings so the ground is pitched to prevent water from running into the excavated areas of a building or damaging other site features.

C. Treatment After Completion of Grading

1. After grading is completed, permit no further excavation, filling or grading, except with the approval of the Engineer.
2. Use all means necessary to prevent the erosion of freshly graded areas during construction and until such time as permanent drainage and erosion control measures have been installed.

3.11 EXCESS WATER CONTROL

A. Unfavorable Weather

1. Do not place, spread or roll any fill material during unfavorable weather conditions.
2. Do not resume operations until moisture content and fill density are satisfactory to the Engineer.
3. Any inundated area that freezes shall be removed and refilled at the Contractor's expense.

B. Provide berms or channels to prevent flooding of subgrade. Promptly remove all water collected in depressions.

C. Pumping, Drainage and Dewatering

1. Provide, maintain and use at all times during construction adequate means and devices to promptly remove and dispose of all water from every source entering the excavations or other parts of the Work.

2. Dewater by means, which will ensure dry excavations, preserve final lines and grades, and do not disturb or displace adjacent soil.

3. All pumping and drainage shall be done with no damage to property or structures and without interference with the rights of the public, owners of private property, pedestrians, vehicular traffic or the work of other contractors, and in accordance with all pertinent laws, ordinances, and regulations.

4. Do not overload or obstruct existing drainage facilities.

3.12 SETTLEMENT

A. The Contractor shall be responsible for all settlement of backfill, fills, and embankments, which may occur within one (1) year after final acceptance of the Work by the City.

B. The Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within thirty (30) days after receipt of written notice from the Engineer.

3.13 CLEANING

A. Upon completion of the work of this Section, remove all rubbish, trash and debris resulting from construction operations. Remove surplus equipment and tools. Leave the site in a neat and orderly condition acceptable to the Engineer, and in conformance with the General Conditions of the Contract Documents.

END OF SECTION 02200

SECTION 02405
BLASTING

PART 1 - GENERAL

1.01 SCOPE

A. This Section covers the work necessary for the use of explosives and blasting in connection with rock excavation for underground excavations including excavations required for the Contractor's convenience.

B. Specifications in this Section govern blast design, blast limitations, explosive materials, equipment, labor, and supervision for transportation and storage of explosives, drilling and loading of blast holes, protection of existing facilities, test blasts, and damage repairs due to Contractor's blasting operations.

C. The Contractor's designated professional responsible for monitoring blasting activities shall participate in a public information program in cooperation with the Owner and Engineer to include furnishing information regarding planned blasting operations and attending public meetings to answer questions and describe the proposed blasting operations.

1.02 DEFINITIONS

A. Smoothwall Blasting (Trim Blasting): A controlled blasting technique used to produce smooth walls in underground excavations. The trim holes are located around the perimeter of the excavation but not along the bottom of the excavation or sidewall holes within three feet of the excavation floor. Trim charges are decoupled to reduce the linear charge density and are placed in holes with reduced spacing and are fired after main charge.

B. Peak Particle Velocity (PPV): The maximum of the three ground vibration velocities measured in the vertical, longitudinal, and transverse directions. Velocity units are expressed in inches per second (ips).

C. Air-Overpressure: Temporary changes in ambient air pressure caused by blasting. Air-overpressure is expressed in units of psi or dB. Measurements for blasting are made with microphones having a flat frequency response for over-pressure in the two (2) to two hundred (200) Hz range. A-weight or C-weight microphones shall not be used for these measurements.

D. Occupied Building: Structure on or off construction limits that is occupied by humans or livestock.

E. Residential Building: Includes single and multi-family dwellings, hotels, motels, and any other structure containing sleeping quarters.

F. Scaled Distance: A factor describing relative vibration energy based on distance and charge-per-delay. For ground vibration control and prediction purposes, Scaled Distance (Ds) is obtained by dividing the distance of concern (D) by the square root of the charge-per-delay (W) - $Ds=D/(W)^{1/2}$.

G. Charge-per-Delay(W): For purposes of vibration control, any charges firing within any eight (8) millisecond time period are considered to have a cumulative effect on vibration and air-

overpressure effects. Therefore, the maximum charge-per-delay equals the sum of the weight of all charges firing within any eight (8) millisecond time period. For example, if two 10 lb. charges fire at 100 ms and one 15 lb. charge fires at 105 ms, the maximum charge per delay would be 35 lbs.

H. Line Drilling: A method of controlling overbreak, in which a series of very closely spaced holes are drilled at the perimeter of the excavation. Line holes are generally not loaded with explosives; however, in some applications alternating holes may be loaded with light charges using detonating cord.

I. Pre-splitting: A blasting technique in which the perimeter charges are detonated first in the firing sequence or as a separate blast ahead of production blasting. This technique is designed to generate a fracture in the plane of the pre-split holes drilled along the perimeter of the excavation.

J. Production Holes: Blast holes in the main body of the rock mass being removed by drilling and blasting.

K. Stemming: Crushed stone, tamped clay or other inert earth material placed in the unloaded collar area of blastholes for the purpose of confining explosive charges and limiting rock movement and air overpressure.

L. Buffer Holes: Holes with reduced energy charges drilled adjacent to smoothwall, trim or open line-drilled holes at the perimeter of the excavation. The explosive charge in buffer holes is generally between fifty (50) and seventy-five (75) percent of the charge used in normal production blastholes. Buffer holes are usually drilled parallel to adjacent holes at the excavation perimeter.

M. Primary Initiation: The method whereby the blaster initiates the blast(s) from a remote and safe location. Primary initiation systems use pneumatic tubing or shock-tubes to convey firing energy from blasters to blast locations.

N. Sub-drilling: The portion of the blasthole that is drilled below or beyond the desired excavation depth or limit. Subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blastholes.

O. Surface Blasting: All excavations where surface blasting techniques are required.

P. Cushion Blasting: A controlled blasting technique for surface excavations. Cushion blasting is a blasting technique in which the line of holes along the boundary of the excavation is detonated during the last delay period of the blast. The main burden is moved from the face by the main production holes, leaving only a small burden to be removed by the line holes on the perimeter. The holes along the perimeter are loaded lighter than the main production holes.

Q. Controlled Blasting: Excavation in rock in which the various elements of the blast, including hole size, position, alignment, depth, spacing, burden, charge size, distribution, and delay sequence are carefully controlled to excavate the rock to the desired lines with a relatively uniform surface with minimal overbreak and fracturing of rock beyond the design excavation limits and to maintain resulting noise, overpressure, and peak particle velocity within specified maximum limits.

R. Prohibited Persons: Persons prohibited from handling or possessing explosive materials as defined by the seven categories described in Title 27, Part 555 of the Code of Federal Regulations (CFR) ATF Rules.

S. Delay: Distinct pause of pre-determined time between detonations of single charges or groups of charges.

1.03 REFERENCED STANDARDS

A. U.S. Department of Justice, Alcohol, Tobacco and Firearms and Explosives Division (CFR Title 27 – Alcohol, Tobacco, and Firearms, Chapter II, Part 555, Implementation of the Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296; Interim Final Rule).

B. Institute of Makers of Explosives

1. Dos and Don'ts - Instructions and Warnings for Consumers in Transporting, Storing, Handling, and Using Explosive Materials.
2. Destruction of Commercial Explosives.
3. Suggested Code of Regulations for the Manufacture, Transportation, Storage, Sale, Possession and Use of Explosive Materials.
4. Safety in the Transportation, Storage, Handling and Use of Explosive Materials.
5. Safety Guide for the Prevention of Radio Frequency Radiation Hazards in the Use of Electric Blasting Caps.

C. National Fire Protection Association (NFPA): NFPA 495 - Code for the Manufacture, Transportation, Storage, and Use of Explosive Materials, 2010 Edition.

D. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Construction Standards and Interpretations 29 CFR Part 1926, Subpart U, Section 1926.900, "Blasting and Use of Explosives", final rule dated December 16, 1972.

E. Official Code of Georgia (OCGA); Code Section 25 - Georgia Blasting Standards Act of 1978, Code Section 25-9-1, et seq.

F. ISEE Field Practice Guidelines for Blasting Seismographs, 2009 ed.

1.04 QUALITY CONTROL

A. The design and execution of blasting shall be performed under the on-site supervision of a licensed blaster certified in the State of Georgia.

B. The Contractor shall perform blast monitoring as required to satisfy its legal obligation relative to all permits and all applicable federal, state and local codes, laws, regulations, and ordinances, and its contractual responsibilities, including safety.

C. The Engineer may perform blast monitoring to verify conformance with regard to air-overpressure (noise) and peak particle velocity criteria defined by this Section.

D. Qualifications and Clearance Status:

1. The blasting supervisors (blasters-in-charge) shall have a minimum of ten (10) years experience, directly related to the specific types of excavation blasting they will oversee. All blasting supervisors shall be able to document the completion of at least three (3) projects of similar scope and complexity.
2. All blasters and supervising shift foremen shall be properly qualified and licensed in accordance with applicable federal, state, and local government regulations. Necessary permits include an Explosives License issued by the Georgia Fire Safety Commissioner.
3. The Contractor shall retain the services of an experienced blasting consultant with at least ten (10) years experience in monitoring blasting operations (test blasts and production blasts), interpreting ground vibration, air overpressure, and impulse amplitudes for similar construction projects, and to prepare all blasting plans, test-blasting plans, and revisions to any of these plans. All blasting plans, test-blasting plans and revisions shall be reviewed by and covered with a signed review letter by the blasting consultant. The blasting consultant will not be required to sign the individual blast plans provided they are signed by an on-site licensed blaster.
4. All persons that handle explosive materials, have control over them, or access to them, and must be licensed or permitted, as defined in CFR Title 27 – Alcohol, Tobacco, and Firearms, Chapter II, Part 555, Subpart D (ATF Rules).

1.05 SUBMITTALS

A. Permits: The Contractor shall submit a copy of all applicable permits and licenses for transportation, storage, and use of explosives to the Engineer prior to the start of blasting operations. Submitted permits must include a copy of Federal ATF blasting license listing all responsible persons, blasting use, and storage permits issued by the Georgia State Fire Marshals Office, and any other necessary local permits. No explosives can be brought to any work sites until all necessary permits have been submitted to the Engineer.

B. Regulations: The Contractor shall obtain at least two (2) copies of all applicable federal, state, and local laws and regulations regarding the use of explosives. One (1) copy of these laws and regulations, shall be submitted to the Engineer at least fourteen (14) days prior to blasting. The second copy shall be maintained on-site in the Contractor's office, for review by all Contractor personnel involved in blasting.

C. Contractor Qualifications and Evidence of Experience: The Contractor shall submit resumes of proposed blasting supervisors to the Engineer. Resumes shall contain listing of experience, references with phone numbers, and copies of all required blasting licenses.

D. Blast Designs and Safety Measures: The Contractor shall submit to the Engineer the following information for initial test blasts and proposed production blast design for each area as appropriate:

1. Number, location, diameter, depth. and orientation of drill holes on a scaled drawing of the excavation or heading face.
2. Type of explosive and weight of charge in each hole.
3. Type and nomenclature of detonators.

4. Type and distribution of stemming used to fill hole collars for charge confinement.
5. Total amount of explosives in the blast and maximum charge-per-delay.
6. Delay arrangement showing delay period in each hole.
7. Description of the proposed blasting system and type of firing source.
8. Specific measures taken to protect structures, buried utilities, and other facilities that may be potentially affected by blasting operations.
9. Type and methods of shaft covers, matting, and containment of blast area to mitigate fly rock.
10. Description of and locations of signage used to announce blast warning signals to any persons that might enter blast areas.
11. Clearing, guarding and communication procedures to confirm that all persons are evacuated to safe areas and that blast areas are secured prior to blasting.
12. Prediction calculations for noise (air-overpressure) and peak particle velocity (PPV) at the closest structure and at other adjacent structures, pipelines, or facilities that may be potentially affected by blasting operations.
13. Any redesign of the blasting program shall be submitted to the Engineer.

E. Blasting Records: The Contractor shall maintain a record of each blast detonated. The Contractor shall submit to the Engineer the following records and information the same day the blasting is performed:

1. Depth of blast holes and the location of the blast point in relation to Project stationing.
2. Type, strength, and quantities of all explosives, types and quantities of detonators, powder factor (lb/cy), and actual firing times of all charges.
3. Total explosive loadings per round and maximum charge per delay.
4. Type of rock blasted.
5. Reference to approved blast design submittal noting any modification.
6. Time spent scaling rock and approval of rock scaling by designated individual.
7. On a diagram of the approved blast pattern indicate any holes not drilled, drilled but not loaded, changes in spacing or in pattern of delay charges or in loading of holes. Include notes explaining why changes were made.
8. Submit an evaluation of the blast indicating tights, areas of significant overbreak, and any recommended adjustments for future blasts.
9. Comments by the blaster in charge regarding any misfires, unusual results, or unusual effects.
10. Date and exact firing time of blast; name of person in responsible charge of loading and firing, and blaster permit number.
11. Signature and title of person making recording entries.

12. Record of peak overpressure: Two copies of all blast vibration monitoring data obtained independent of monitoring performed by the Engineer. Submit hard copies of 4-channel waveforms for each blast.

13. Any other records required by federal, state and local laws and regulations.

F. Blasting Safety and Security Plans:

1. A complete description of the clearing and guarding procedures that will be employed to ensure personnel, staff, visitors, and all other persons are at safe locations during blasting. This information shall include details regarding visible warning signs or flags, audible warning signals, method of determining blast area zones, access blocking methods, guard placement and guard release procedures, primary initiation method, and the system by which the blaster-in-charge will communicate with site security guards.

2. Detailed description of how explosives will be safely stored, transported, and used at the various work sites. Plans shall explain how storage magazines and explosive transport vehicles will satisfy all applicable regulations. This plan shall also indicate how explosives will be inventoried, secured, and guarded to prevent theft or unauthorized use of explosives.

3. If the Georgia State Fire Marshal authorizes overnight storage of the explosives, the Contractor must submit a detailed storage plan that includes scaled maps indicating proposed location of detonator and explosives that will be stored overnight, distances to nearest occupied buildings, roadways, and other limiting items in the American Table of Distances.

4. The Contractor shall include Material Safety Data Sheets (MSDS) and specific details about hazard communication programs for employees.

5. Equipment that will be used to monitor the approach of lightning storms and in the event of such, evacuation and site safety security plans.

6. Contingency plans for handling of misfires caused by cut-offs or other causes.

7. Fire prevention plan details, including smoking policies, procedures, and limitations for work involving any open flames or sparks, description and location of all fire fighting equipment, and fire fighting and evacuation plans.

8. Initial and ongoing blasting and fire safety training programs.

9. Description of the personal protective equipment that will be used by the Contractor's personnel, including but not limited to, safety glasses, hard-toe footwear, hard hats, and gloves.

10. Description of blast monitoring equipment and listing of individuals that will operate such equipment. Submittal shall indicate that all equipment meets the standards defined in Article 2.02 of this Section.

11. The Contractor's Safety Representative shall ensure that ongoing blasting work complies with all applicable federal, state, and local regulations.

12. The Contractor shall submit copies of ATF Employee Possessor questionnaire forms (OMB No. 1140-0072) or ATF letters of clearance for all employees that will possess explosives for this Work as defined in 27 CFR Part 555. Contractor employees without submitted evidence of satisfactory ATF clearance, must not handle, control, or have access to explosive materials.

13. Ground Vibration and Air-Overpressure Monitoring Records: Submit two (2) copies of all 4-channel monitoring records done independently of the monitoring performed by the Engineer.

14. The Contractor shall deliver to the Engineer, fourteen (14) days prior to the start of blasting at any location, two bound copies of the property condition inspection reports (condition survey) containing all field notes, sketches, diagrams, photos, and videos as required in the Agreement Documents

G. Notification:

1. For all work sites prior to starting blasting, the Contractor shall notify the appropriate local municipal officials, above- and below-ground utility owners and the Engineer who will notify the general public expected to be potentially affected by blasting operations. Notice shall be given to all operators of all buried pipes, cables, conduits, and overhead utility lines and poles located within a two hundred (200)-foot radial distance of the blast area.
   Notification to appropriate local municipal officials and utility owners or operators shall be done in writing, at least forty-eight (48) hours prior to the start of blasting at a particular site or sooner if so required by any applicable laws or regulations, and shall indicate the expected frequency of blasting, hours that blasting might occur and the expected date that blasting will be completed. Upon completion of blasting at the particular site, utility owners or operators shall be notified that blasting has ceased in the area for the duration of the Project.

2. The Contractor shall furnish the Engineer with a list of those parties notified in accordance herewith prior to the start of such blasting. The list shall include names, addresses, and telephone numbers of those notified.

3. The Contractor shall submit copies of written notification letters sent to the responsible fire protection agency for any sites where explosives are stored overnight. These letters shall be submitted to the Engineer at least forty-eight (48) hours before any explosives are stored at the site. These letters must be submitted by the Contractor to the responsible fire protection agency, forty-eight (48) hours before explosives are stored at the site.

H. Pre-Blast Survey:

1. A pre-construction survey shall be conducted on and reported for all structures within the influence range of any blasting operations or within a minimum of 500 feet from the site perimeter, whichever is greater. The survey shall consist of a visual inspection and recording by notes and photographs of cracks or other structural damage previously sustained, and shall be conducted by a qualified technical furnished by the Contractor's insurance underwriter.

2. A copy of all notes and photographs shall be submitted to the Engineer prior to the commencement of blasting operations. The records so obtained shall be retained by the Contractor for at least one year after completion of the Contract.

3. In the event of damage claims, a report shall be prepared by the Contractor on the particular structure(s) as requested by the engineer or Owner from those notes and photographs and submitted to the Owner.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The Contractor shall deliver all explosives to magazines by land transportation in accordance with all applicable federal, state, and local laws and regulations.

B. Storage of Explosives:

1. Transportation, use, and storage of explosives shall be as prescribed by the most stringent of the rules promulgated by all federal, state and local laws, regulations,, and these Specifications.
2. Initiation devices shall not be stored, transported, or kept in the same place in which other explosives are stored, transported, or kept.
3. Only those explosive materials required for a twenty-four (24)-hour period shall be allowed at the site of the Work. Storage of explosives during non-blasting periods is not permitted and the day-storage magazine shall be empty during these periods.
4. The Contractor shall provide a dedicated on-site vehicle that meets all applicable DOT and OSHA standards regarding the transportation of explosive materials from the magazine to the blasting site. Records shall be maintained that clearly show quantities and types of all explosive materials and detonators received from suppliers and returned to them. The differences in received and returned quantities must accurately correspond with the amounts reported in blasting records.
5. No statement in these Specifications shall be considered to relieve the Contractor from sole responsibility for the safe transportation, use, and storage of explosives.

1.07 GROUND CONDITIONS

A. A geotechnical investigation was performed and the resulting report is included in the Appendix for information. The Contractor shall satisfy himself as to the existing ground conditions above and below the ground surface.

1.08 JOB CONDITIONS

A. Blasting must be performed safely in accordance with applicable federal, state, and local laws and regulations, including those promulgated by OSHA. The Engineer will exercise his prerogative to examine, carefully, the qualifications of any persons whose knowledge and skills may bear on the outcome of the Work. In addition, the Engineer may reject any person who is deemed unqualified for any tasks that may be required.

B. Methods of construction shall be such as to ensure the safety of the Work, Project participants, the public, third parties, and adjacent property, whether public or private. The Contractor is solely responsible for maintaining safe working conditions at the site of the Work.

1.09 INDEMNITY

A. Notwithstanding full compliance with this Section, review of all submittals and successful limitation to the peak particle velocity specified in the Georgia Blasting Standards Act, the Contractor shall be solely responsible for any damage, direct or indirect, arising from blasting and

shall hold the Owner, Engineer and their consultants harmless from any costs, liens, charges, claims or suits, including the costs of defense, arising from such damage, real or alleged.

B. The Owner, the Engineer and their consultants shall be additionally-named insured on any insurance policy covering blasting carried by the Contractor and this requirement shall also be enforced on any subcontractor.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Only explosive and initiation devices packaged by federally-licensed explosives manufacturing firms shall be used in blasting. All explosives and Blasting agents to be used underground shall meet the Fume Class I requirement of the Institute of Makers of Explosives (IME). This restriction does not apply to detonation cords that may be used for trunk lines or in controlled perimeter blasting charges.

B. Only packaged or cartridge type, non-flowing explosives shall be used in the Work. Black powder and nitroglycerine are prohibited for all blasting.

C. Non-electric detonating devices shall be used.

D. Only explosives designed and manufactured for smoothwall (trim) blasting shall be used in perimeter holes for blasting in the underground excavations. The linear charge-weight-per-foot of explosives shall not exceed 0.4 lb/ft. This limitation does not apply to the primer stick, which must not weigh more than one-half (1/2) pounds. Cartridge configurations and detonating cord shall be included in the linear charge weight-per-foot.

E. Explosives, blasting agents, primers, initiators, and ancillary blasting materials shall be kept in original packaging with clearly marked date codes. All explosives and initiating devices used shall be less than one (1) year old.

F. If the Engineer determines that a blasting product appears to be in a damaged or deteriorated condition, the suspect product shall not be used until its condition can be determined. Products found to be damaged or in a deteriorated condition shall immediately be returned to the supplier for safe disposal.

2.02 BLAST MONITORING EQUIPMENT

A. Equipment for on-site and off-site particle velocity and air overpressure monitoring shall be four (4)-channel (one (1) overpressure and three (3) seismic channels) units capable of digitally storing collected data. Equipment must be capable of printing ground motion time histories and summaries of peak motion intensities, frequencies and USBM RI8507 PPV frequency plots. Printed report records must also include date, time of recording, operator name, instrument number and date of last calibration.

1. Instruments shall have a flat frequency response between two (2) and two hundred and fifty (250) Hz for particle velocity and from two (2) to two hundred (200) Hz for air-overpressure.

2. The digitizing sampling rate for peak particle velocity and air overpressure measurements shall be at least 1,024 samples per second.

3. Seismographs shall be capable of performing a self-test of velocity transducers and printed event records shall indicate whether or not the sensor test was successful.

4. Seismographs used for off-site compliance monitoring shall be capable of recording overpressure from one hundred (100) to one hundred and forty-eight (148) dB-L, and particle velocity from 0.05 to 5.0 inches/second.

5. Systems shall be capable of providing printed event reports that include all peak measurements, frequencies and complete waveform plots.

6. Seismographs shall have adequate memory to digitally record the entire duration of the blast-induced motion.

7. All seismograph/software systems shall be capable of saving back-up copies of all event files.

8. If the frequency of blast-induced ground motion for close-in blasting is expected to exceed two hundred and fifty (250) Hz, monitoring shall be done with instruments that measure acceleration with intensities up to ten (10) gs and at frequencies between 200 and 5,000 Hz.

B. The Contractor shall supply the Engineer with four (4) blast monitoring units as described in Article 2.02, Paragraph A of this Section, for the duration of the blasting and for each area of the Project where blasting is taking place. The Contractor shall provide for annual calibration for each of the blast monitoring units and any repair or maintenance required.

2.03 CONDITION SURVEY

A. Prior to the commencement of any underground or surface blasting operation, a pre-blast survey shall be conducted in accordance with the requirements of Section 1.05 and the Agreement Documents.

PART 3 - EXECUTION

3.01 GENERAL BLASTING LIMITATIONS

A. Blasting shall be limited to the hours of 7:00 a.m. to 7:00 p.m., Monday through Friday, and 9:00 a.m. to 5:00 p.m. on Saturdays. Blasting is not allowed on Sundays or Holidays.

B. Blasting vibration and air-overpressure limitations are defined in Articles 3.05 and 3.06 below.

3.02 WARNING SYSTEM

A. The Contractor shall erect signboards of adequate size stating that blasting operations are taking place in the area, and such signs shall be clearly visible at all points of access to the area. These signs shall also clearly display the audible warning signals (horn signals) that will be used to warn all people in the area of the impending blast.

B. An audible blast warning system shall be established, publicized, and operated only during blasting hours.

C. The Contractor shall operate a system to ensure that no personnel remain underground during blasting operations and blasting operations shall not be undertaken until it can be demonstrated that all personnel are accounted for and in a safe location.

3.03 BLASTING OPERATIONS

A. The Engineer shall be notified twenty-four (24) hours before blasts occur at any specific location. The Contractor shall provide the Engineer with a schedule for all blasts and shall notify the Engineer if any blast is delayed for more than one hour. However, the Contractor will be allowed to re-shoot missed holes and tights, as they are uncovered without advance notice to the Engineer.

B. Acceptable Controlled Blasting methods will be those utilizing smooth wall blasting, cushion blasting, and line drilling techniques. Use of "pre-splitting" in shafts and surface excavations is specifically prohibited. Maximum drill round lengths, including subdrilling shall not exceed 0.75 times the minimum dimension of the excavation opening, or as limited by ground conditions. The first eight feet of any excavation shall utilize rounds that do not exceed four feet in length. The four foot round length restriction does not include subdrilling which shall not exceed six (6) inches.

C. Holes shall not be charged with explosives at the same time that drilling or other mechanized equipment not needed to charge the round is being operated within fifty (50) feet of the blast area.

D. The first blasting operation shall be conducted by the Contractor as a test case. The first test blasts shall be no larger than twenty-five (25) percent of the planned production design blast sized as measured by charge-weight-per-delay. The second and third test blasts shall be no larger than sixty (60) and one hundred (100) percent respectively of the planned production design blast. Alternate test blasting plans may be proposed by Contractor with approval of Engineer. After each test blast and review of test blasting data, the Contractor and Engineer shall meet to review the program. Modifications to the blasting program may be required as a result of this review. Drilling and delay patterns, amount and type of explosive to be used in subsequent production blasts shall be revised according to the results of the test case.

E. Monitoring and recording of air-overpressure and vibration will be performed by the Engineer for every test blast round. Changes in drilling and delay patterns and amount of explosives shall be made when test blasts indicate vibrations and/or overpressures in excess of that specified herein. Any major changes in the production blast design shall be submitted to the Engineer.

F. All blasts in open cut excavations shall be covered with a sufficient number of steel cable mats or other substantial covering device in order to prevent injury to persons and property, including the structure and equipment used in connection with shaft or tunnel operation, from flying rock or other material.

When blasting underground, the Contractor shall ventilate the excavation prior to personnel entering. After a blast is fired, all loose and shattered rock or other loose material, which may endanger the structure or the workers shall be removed and the excavation made safe before proceeding with work. Before drilling of blast holes for a new round, the face shall be thoroughly cleaned and examined for missed holes and unexploded charges. Blasting techniques shall be developed and improved as work progresses. The fact that the removal of loose or shattered rock or other loose material may enlarge the excavation beyond the required limits shall not relieve the Contractor of responsibility for such removal and subsequent additional backfill or concrete, and the Contractor shall not be entitled to additional payment for overexcavation or overbreak.

G. No blasting is allowed within forty (40) feet of freshly placed concrete or grouted rock until twelve (12) hours has elapsed since placement. Shotcrete is exempt from these requirements.

H. All transportation of explosives on the surface or underground and any handling, blast charging or tie-in operations shall be stopped immediately upon the approach of an electrical storm, and all persons shall immediately be evacuated from the blasting area to a place of safety. Persons underground shall be notified of the approach and cessation (all clear) of an electrical storm, each by means of different signals. In underground excavations or other excavations, handling of explosives, loading of holes, connecting up or firing of charges shall not be performed during an electrical storm and all persons shall withdraw to a safe distance from a partially or totally loaded face. During such storms, explosives on the surface shall be left in OSHA-approved transport containers, delivery vehicles, day-storage boxes or in approved storage magazines. At all times, explosives shall be watch guarded and secured by the Contractor's personnel that are in safe locations.

I. All light and power circuits shall be disconnected and/or removed to a point not less than one hundred (100) feet from the face while explosives are being transported into the area and while the loading operations are taking place. During the loading operations only OSHA approved lighting may be used.

3.04 SMOOTHWALL BLASTING

A. Excavation to final rock surfaces shall be carried out using smoothwall blasting techniques to minimize the damage to the finished rock surface.

B. The perimeter holes for smoothwall blasting shall conform to the following requirements:

1. Hole spacing shall not exceed eighteen (18)-inches unless a variance is approved by the Engineer. Justification to increase hole spacing shall be based on results from the test blasts.
2. Explosives, excepting the primer stick, shall be distributed evenly and de-coupled from wall of hole. The maximum charge-weight-per-foot of the primary column explosive (loading factor) shall not exceed 0.4 lb/ft. The weight of the primer stick or booster used in smoothwall-perimeter holes shall not exceed 0.5 pounds.
3. Burden shall be between 1.2 and 1.5 times the hole-spacing.
4. Lookout of perimeter holes shall be limited to the minimum necessary to collar the next round.

3.05 AIR-OVERPRESSURE LIMITATIONS

A. Air-overpressure shall not exceed one hundred and thirty (130) decibels when measured at the nearest occupied building.

B. To meet the specified one hundred and thirty (130) dB air-overpressure limit, the Contractor should be prepared to install additional sound reducing materials on the shaft cover, stem blastholes with tamped clay dummies, or use whatever other additional measures are needed to conform to the one hundred and thirty (130) dB limit.

C. All measurements of blast-induced air-overpressure shall be done in accordance with ISEE Field Practice Guidelines for Blasting Seismographs, 2009 edition.

3.06 VIBRATION LIMITATIONS

A. The maximum intensity of motion in the vertical, longitudinal, and transverse directions, measured in the ground near any adjacent residential or occupied building shall not exceed one-half (1/2) inch per second at any frequency of motion.

B. The maximum intensity of motion in the vertical, longitudinal and transverse directions, measured on the ground above any buried utility lines or pipes shall not exceed four (4) inches per second at any frequency of motion.

C. The Contractor shall monitor each blast with a minimum of four (4) seismographs located, as approved, between the blast area and the closest structures and/or utilities.

D. All measurements of blast-induced vibrations shall be done in accordance with ISEE Field Practice Guidelines for Blasting Seismographs, 2009 edition.

3.07 SUSPENSION OF BLASTING

A. Blasting operations may be suspended by the Engineer for any of the following reasons:

1. The Contractor's safety precautions are inadequate.
2. Air overpressure or ground motion levels exceed specified limits.
3. Existing structural conditions on and off site are aggravated and are damaged by blasting.
4. Blasting causes instability of slopes or causes damage to rock outside the prescribed limits of excavation.
5. The results of the blasting, in the opinion of the Engineer, are not satisfactory.
6. Failure of the Contactor to adhere to the submitted and accepted blast plan.

B. Blasting operations shall not resume until the Engineer has approved the Contractor's revised blasting plan with modifications correcting the conditions causing the suspension.

3.08 DAMAGE REPAIR

A. When blasting operations damage off-site properties or a portion of the Work or material surrounding or supporting the Work, the Contractor shall promptly repair or replace damaged items to the condition that existed prior to the damage at no cost to the Owner and to the satisfaction of the Engineer.

END OF SECTION 02405

SECTION 02510
PAVING

PART 1 - GENERAL

1.01 SCOPE

A. The work under this Section includes, but it is not necessarily limited to, the furnishing and installation of all concrete and asphalt paving materials and pavement base materials as indicated on the Drawings and as necessary for the proper performance of this work.

B. Related Work specified elsewhere: Section 02200 - Earthwork.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Batch design.
2. Density and viscosity tests on each run.
3. Weight slips for pavement base and asphalt paving materials.
4. Certificate signed by the asphalt supplier and the Contractor stating that materials comply with the specifications.
5. Traffic paint manufacturer's application instructions and a description and other data relative to the Contractor's application equipment and methods.

1.03 QUALITY ASSURANCE

A. Unless otherwise indicated on the Drawings or herein specified, all work under this Section shall be performed in accordance with the current Georgia Department of Transportation Standard Specifications for Transportation Systems.

B. Furnish weight slips for all material incorporated in the Project to verify that the required tonnage has been applied.

C. Use only materials which are furnished by a bulk asphalt concrete producer regularly engaged in production of hot-mix, hot-laid asphalt concrete. The Georgia Department of Transportation must currently rate material suppliers as furnishing acceptable materials for State Highway Projects.

D. Retain a test laboratory equipped and qualified to test the materials.

E. Protect all manholes and valve covers from damage due to the paving operation.

1.04 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect the installed work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to gain the approval of the Engineer at no additional cost to the City.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials and products for the work under this Section shall conform to the current Georgia Department of Transportation Standard Specifications for Transportation Systems except as otherwise specified herein.

PART 3 - EXECUTION

3.01 GENERAL

A. The roadway and curbing construction shall meet the Georgia Department of Transportation Specifications.

B. In the event that construction materials are to be supplied for pavement construction on this contract similar to those being produced for similar work by others which are being tested by a reputable testing laboratory or by representatives of the Georgia Department of Transportation, certified copies of the tests and inspections reports on such materials, if in compliance with the contract, will be accepted in lieu of separate tests by a testing laboratory.

3.02 PROTECTION AND MAINTENANCE

A. The Contractor shall be responsible for the protection and maintenance of any existing roadbed or any roadbed constructed during the contract. The roadbed shall be maintained free from ruts and other depressions, in a smooth and compacted condition and true to lines and grades. Any of the Contractor's hauling and other equipment used in such a way as to cause excessive rutting or raveling of the roadbed material shall either be removed from the work or suitable runways shall be provided to prevent rutting.

3.03 TESTING AND INSPECTION SERVICES

A. All materials to be incorporated in the construction of pavements shall be subject to the tests and inspections listed herein and in the standard specifications referred to in this section.

B. The cost for testing for material compliance shall be paid for by the Contractor. The Contractor shall pay for any re-testing required due to test failures.

C. The Contractor shall provide at his expense the testing and inspection services required by the Contract Documents.

D. The Contractor shall employ and pay for the services of a testing laboratory to perform specified services and testing. Employment of the laboratory shall in no way relieve Contractor's obligations to perform the work of the Contract.

E. The Contractor shall advise the Engineer at least 48 hours before tests are to be conducted.

3.04 SOIL CLASSIFICATIONS

A. The minimum tests required on soil materials to prove compliance with the specifications, which are to be paid for by the Contractor, shall be as follows:

B. A determination of soil classification, including sieve analysis and Atterburg Limits of soil material proposed for use as base shall be made from each material source.

C. If base material is to be road mixed, the tests shall be taken for each 6,000 square yard of base to be placed.

D. Maximum Dry Densities (Proctors): One (1) test representative of the soils for each in-place density test.

3.05 IN-PLACE DENSITY (COMPACTION TEST)

A. At least one (1) test shall be made on the roadbed for each 1,000 linear feet or 25,000 square feet (or portion) of pavement to be placed.

B. At least one (1) test shall be made on each lift of base for each 1,000 linear feet or 25,000 square feet (or portion) of pavement to be placed.

C. Test requirements on surface course materials, including: marshal density tests every 1,000 linear feet and corings (if deemed necessary by the Engineer), shall be made at the direction of the Engineer to prove compliance with the specifications. The Contractor shall pay for such tests.

3.06 CITY TESTING

A. The City reserves the right of performing tests as frequently as deemed necessary above and beyond that, which is required by this section to be performed and paid for by the Contractor.

B. The Contractor shall cooperate fully with the Testing Laboratory of the City and render any assistance necessary in order to facilitate the necessary sampling and testing work.

C. If requested by City, Contractor shall perform such additional tests for City by the Contractor's testing facility for which Contractor will be reimbursed.

D. Unless otherwise designated by the authority having jurisdiction over the road, street, or highway involved, minimum traffic requirements shall be one way traffic from sun up to sun down and two-way traffic from sun down to sun up. Flagmen shall be required during periods of one-way traffic.

3.07 CLEANING

A. Prior to acceptance of the work of this Section, clean the pavement and related areas in accordance with the requirements of the General Conditions of the Contract Documents.

END OF SECTION 02510

SECTION 02530
CONCRETE WALKS

PART 1 - GENERAL

1.01 SCOPE

A. The extent of concrete walks is as shown on the Drawings or as required to replace existing walks damaged or destroyed by the Contractor's work.

B. Concrete walk construction includes, but is not limited to, the furnishing, placing, forming, finishing, curing and jointing of Portland cement concrete on prepared subgrade for walks, sidewalks, wheelchair and/or curb cut ramps, paved medians, and drive ramps.

1.02 RELATED SECTIONS

A. The Work of the following Sections specifically apply to the Work of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of Work.

1. Section 02532 - Concrete Curbs and Gutters

2. Section 03300 - Cast In-Place Concrete

PART 2 - PRODUCTS

2.01 MATERIALS

A. Forms: Either full depth steel or wood forms of a size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use forms that are straight and free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends.

B. Concrete: Ready-mix concrete of 3,000 psi comprehensive strength conforming to ASTM C94 except where small quantities are needed. In which cases, small capacity batchers or mixers may be used.

C. Joint Filler: Preformed joint filler meeting AASHTO M153 or AASHTO M213.

2.02 CONCRETE MIX

A. Design the mix to produce standard-weight concrete consisting of Portland cement, aggregate and water to produce the following properties:

1. Compressive Strength: 3,000 psi minimum at 28 days as determined by ASTM C39.

2. Slump: 4 inches maximum per ASTM C143.

3. Air Content: 3% to 6%.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Remove loose material from compacted subgrade immediately before placing concrete.

3.02 FORM CONSTRUCTION

A. Set forms to the required grades and lines rigidly braced and secured.

B. Check completed formwork for grade and alignment to the following tolerances:

1. Top of form: Within 1/8 inch of design line and grade.

2. Vertical face: Not more than 1/4 inch in 10 feet from vertical.

C. Thoroughly clean forms and coat with form release agent as required, ensuring form separation from concrete without damage before placing concrete.

D. Slip form placement methods will be permitted provided completed walks meet requirements herein specified. Should slip form method not produce a product conforming to these specifications, the unacceptable work is to be removed and reconstructed, at no additional cost to the City, using fixed forms.

3.03 REINFORCEMENT

A. Locate, place and support reinforcement (if any), as indicated or specified.

3.04 CONCRETE PLACEMENT

A. Do not place concrete until subgrade and forms have been checked for line and grade. Moisten subgrade as required to provide a uniform dampened condition at the time concrete is placed. Do not place concrete on muddy or frozen subgrade.

B. Place concrete in one course, monolithic construction, for the full width and depth of walks.

C. Spread concrete as soon as it is deposited on the subgrade using methods that prevent segregation and separation of the mix, and with as little re-handling as possible. Consolidate concrete along the face of forms and adjacent to transverse joints.

3.05 JOINTS

A. General: Construct expansion and weakened plane contraction joints true to line with face perpendicular to surface of the walk, unless otherwise shown. Construct transverse joints at right angles or radial to the walk centerline, unless otherwise shown. When the walkway is abutting existing walks, place transverse joints to align with previously paved joints, unless otherwise indicated.

B. Contraction Joints: Provide weakened plane transverse joints as shown on the Drawings. Construct joints for a depth equal to at least 1/3 the walk thickness, using one of the following procedures:

1. Tooled Joints: Form joints in the fresh concrete by grooving the top portion of slabs and finishing edges to a 1/4 inch radius.

2. Sawed Joints: Cut joints, approximately 3/16 inch wide, into hardened concrete as soon as the surface will not be torn, abraded, or otherwise damaged by the cutting action.

C. Expansion Joints: Form expansion joints with 1/2 inch thick premolded joint filler. Locate transverse expansion joints no more than 100 feet apart. Where walks abut cold joints, curbs, existing walks, walls, catch basins, manholes, or other structures, provide expansion joint. Furnish joint fillers in one-piece that extend the full width and depth of the joint. After concrete is finished, trim any protruding joint material flush with concrete surface.

3.06 CONCRETE FINISHING

A. After striking off and consolidating concrete, smooth the exposed surface to a uniform finish by screeding and floating.

B. Before the surface is given the final finish, test the surface for trueness with a 10 foot straightedge. Correct any irregularities more than 1/4 inch in 10 feet.

C. Round all edges to 1/4 inch radius.

D. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing, as follows: Broom finish: by drawing a stiff-bristle broom across the concrete surface, perpendicular to walk centerline.

3.07 CURING

A. Protect and cure finished concrete walks with type 2 membrane curing compound.

3.08 REPAIR AND PROTECTION

A. Repair or replace broken or defective walks using methods acceptable to the Engineer. Where removal is required, remove and replace complete panels.

B. Protect completed walks from damage until final acceptance.

C. Clean concrete walks free of stains, discolorations, dirt, trash, leaves and other foreign material just prior to substantial completion and final acceptance.

END OF SECTION 02530

SECTION 02532
CONCRETE CURBS AND GUTTERS

PART 1 - GENERAL

1.01 SCOPE

A. The extent of concrete curbs and gutters is as shown on the Drawings or as required to replace curbs and gutters damaged or destroyed by the Contractor's work.

1.02 RELATED SECTIONS

A. The Work of the following Sections specifically apply to the Work of this Section. Other Sections of the Specifications, not referenced below, shall also apply to the extent required for proper performance of Work.

1. Section 02530: Concrete Walks

2. Section 03300: Cast In-Place Concrete

PART 2 - PRODUCTS

2.01 FORMS

A. Either full depth steel or wood forms of a size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use forms that are straight and free of distortion and defects.

B. Use flexible spring steel forms or laminated boards to form radius bends as required.

2.02 CONCRETE

A. Ready-Mix concrete, 3,000 psi compressive strength, conforming to ASTM C94.

2.03 JOINT FILLER

A. Preformed joint filler meeting AASHTO M153 or AASHTO M213.

2.04 CONCRETE MIX

A. Comply with applicable requirements of Section 03300 for concrete mix design, sampling and testing, and quality control, and as herein specified. Design the mix to produce standard-weight concrete consisting of Portland cement, aggregate and water to produce the following properties:

1. Compressive Strength: 3,000 psi minimum at 28 days as determined by ASTM C39.

2. Slump: 4 inches maximum per ASTM C143.

3. Air Content: 3% to 6%.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Remove loose material from compacted subgrade immediately before placing concrete.

3.02 FORM CONSTRUCTION

A. Set forms to the required grades and lines rigidly braced and secured.

B. Check completed formwork for grade and alignment to the following tolerances:

1. Top of Form: Within 1/8 inch of design line and grade.

2. Vertical Face: Not more than 1/4 inch in 10 feet from vertical.

C. Thoroughly clean forms and coat, with form release agent as required ensuring form separation from concrete without damage, before placing concrete.

3.03 REINFORCEMENT

A. Locate, place and support reinforcement, if any, as indicated or specified.

3.04 CONCRETE PLACEMENT

A. General: Comply with the applicable requirements of Section 03300 for mixing and placing concrete and as herein specified.

B. Do not place concrete until subgrade and forms have been checked for line and grade. Moisten subgrade as required to provide a uniform dampened condition at the time concrete is placed.

C. Place concrete using methods that prevent segregation and separation of the mix, and with as little re-handling as possible. Consolidate concrete along the face of forms with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Discontinue vibration before segregation or excessive surface grout occurs. Perform any necessary hand spreading and consolidation with hand tools that will not cause segregation and separation.

D. Deposit and spread concrete in a continuous operation between transverse joints, as far as possible.

E. Machine methods of placing and forming may be used at Contractor's option, provided that an acceptable finished product, true to line, grade and cross section and conforming to specified finish and jointing requirements, is consistently produced. If machine results are not acceptable, remove and replace with formed concrete as specified.

3.05 JOINTS

A. General: Construct contraction and expansion joints true to line with face perpendicular to surface of curb and gutter, unless otherwise shown. Construct transverse joints at right angles or radial to the curb centerline, unless otherwise shown.

B. When curb and gutter is constructed abutting concrete pavement, place transverse joints to align with pavement joints.

C. Contraction Joints: Provide contraction joints at intervals of 10 feet, except where a lesser interval is required for closure, but no section is to be less than 6 feet in length.

1. Contraction joints may be formed by metal divider plates or may be sawed. In either case, joint depth is to be 20 to 25 percent the depth of the concrete.

D. Expansion Joints: Form expansion joints with 1/2 inch thick pre-molded joint filler. Locate expansion joints no further than 100 feet apart, unless otherwise shown, where curb and gutter is constructed adjacent to asphalt concrete paving. Match pavement expansion joints where curb and gutter is placed abutting concrete pavement.

E. Furnish joint fillers in one-piece that extend the full width and depth of the joint. After concrete is finished, trim any protruding joint material flush with concrete surface.

3.06 CONCRETE FINISHING

A. After striking off and consolidating concrete, smooth the exposed surface to a uniform finish by screeding and floating.

B. With the exception of sawed joints, round all joint edges to 1/4 inch radius.

C. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing as follows:

1. Broom finish, by drawing a fine-hair broom across the concrete, perpendicular to the line of traffic.

2. Trowel finish, smooth, and free of trowel marks, uniform in texture and appearance.

3.07 CURING

A. Protect and cure finished concrete curbs and gutters complying with applicable requirements of Section 03300.

3.08 REPAIR AND PROTECTION

A. Acceptably repair or replace broken or defective curbs and gutters.

B. After the concrete has set sufficiently, backfill and compact adjacent ground to design line and grade.

C. Protect completed curbs and gutters from damage until final project acceptance.

D. Clean concrete curbs and gutters free of stains, discolorations, dirt, trash, leaves, and other foreign material just prior to final inspection.

END OF SECTION 02532

SECTION 02710
ANTI-RAM BARRIER FENCING AND GATES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of anti-ram barrier fences, gates and motors as indicated on drawings.

1.02 SECTION INCLUDES

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Section 03300- Cast in Concrete

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical data, and installation instructions for metal fencing, fabric, gates and accessories.

1.04 QUALITY ASSURANCE

A. Provide anti-ram barrier system, panels, and gates as complete units controlled by a single source including necessary erection accessories, fittings, and fastenings.

B. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and materials and techniques specified.

1.05 REFERENCES

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

B. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.

C. ASTM D523 - Test Method for Specular Gloss.

D. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.

E. ASTM D822 - Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.

F. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

G. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

H. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

I. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.

J. ASTM F2656 – Standard Test Method for Vehicle Crash Testing of Perimeter Barriers

K. Federal Specification RR-W-410E / Wire Rope and Strand.

L. ASTM F2408 – Ornamental Fences Employing Galvanized Steel Tubular Pickets.

PART 2 - PRODUCTS

2.01 GENERAL

A. This system shall be tested and certified to meet ASTM F2656, Impact Condition Designation M50, Penetration Rating P1, with capability of stopping a 15,000 lb vehicle traveling at speeds up to 50mph.Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include; but are not limited to, the following:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   a. Anti-ram barrier fencing and gate system:
      i) Ameristar Fence Products, Inc.
      ii) SecureUSA
      iii) Payne Fence Products

2.02 FENCE PANELS

A. Material

1. Steel material for cable-supporting framework (i.e., corrugated pales, rails and posts) shall be galvanized prior to forming and shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 psi (310 MPa). The steel shall be hot-dip galvanized to meet the requirements of ASTM A653/A653M with a minimum zinc coating weight of 0.90 oz/ft2 (276 g/m2), Coating Designation G-90.

2. Material for corrugated pales shall be a nominal 2.75" x .75" x 14 Ga. The cross-sectional shape of the rails shall conform to the manufacturer's Stalwart IS rail design a nominal 2" x 2" x 11 Ga. Pre-drilled holes in the Stalwart IS rail shall be spaced 6" on center, providing a pale airspace of no greater than 3.25". Tamperproof fasteners shall be used to fasten each pale to rail at every intersection. Posts shall conform to the manufacturer's Stalwart IS I-Beam design with a nominal 3" x 2.75" x 12 Ga.

3. Material for corrugated pales shall have a nominal material thickness of 0.075 inches. The cross-sectional shape of the rails shall conform to the manufacturer's Impasse™ rail design with a nominal thickness of 0.100 inches. Pre-drilled holes in the Impasse™ rail shall be spaced 6" o.c. Tamperproof fasteners shall be used to fasten each pale to each rail. Posts shall conform to the manufacturer's Impasse™ I-Beam design with a nominal thickness of 0.100 inches.

4. The cable material shall be 1-1/2" diameter structural wire strand conforming to ASTM A586, Grade 2, Class A coating throughout, with a breaking strength of 159 tons. Cables shall be equipped with threaded studs swaged to a holding strength equivalent to cable breaking strength.

B. Fabrication

1. Pales, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept tamperproof security fasteners. Post flange shall be pre-punched to accept rail to post attachment. Post web shall be punched providing a clear opening for interior of rails to align throughout the entire system for affixing conduit, video cabling, IDS wiring, and other components for a complete systems integration. Rails shall be attached to post flange providing a bracket-less design at each intermediate post

2. The manufactured galvanized framework shall be subjected to the PermaCoat® thermal stratification coating process (high-temperature, in-line, multi-stage, multi-layer) including, as a minimum, a six-stage pretreatment/wash (with zinc phosphate), an electrostatic spray application of an epoxy base, and a separate electrostatic spray application of a polyester finish. The base coat shall be a thermosetting epoxy powder coating (gray in color) with a minimum thickness of 2 mils (0.0508mm). The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be black. The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.

Table 1 – Coating Performance Requirements

Quality Characteristics	ASTM Test Method	Performance Requirements
Adhesion	D3359 – Method B	Adhesion (Retention of Coating) over 90% of test area (Tape and knife test).
Corrosion Resistance	B117, D714 & D1654	Corrosion Resistance over 3,500 hours (Scribed per D1654; failure mode is accumulation of 1/8" coating loss from scribe or medium #8 blisters).
Impact Resistance	D2794	Impact Resistance over 60 inch lb. (Forward impact using 0.625" ball).
Weathering Resistance	D822 D2244, D523 (60° Method)	Weathering Resistance over 1,000 hours (Failure mode is 60% loss of gloss or color variance of more than 3 delta-E color units).

2.03 SLIDING ROLL GATES

A. Fabrication:

1. Fabricate gates from metal and finish to match fence framework. Assemble gate frames by welding or with special fittings and rivets for rigid connections, providing security against removal or breakage connections. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware and accessories.

2. Pales, rails, uprights and posts shall be precut to specified lengths. Diagonals shall be precut to specified lengths and angles. Frame materials shall be joined by welding. Pales shall be face welded to roll gate frame, except for Gauntlet style gates over 18' long. Gauntlet style

gates over 18' long shall have pales face-welded to 2" x 2" angle iron to form panels equal in length to the gate frame bay width.

3. The manufactured roll gates and bolt-on panels (if applicable) shall be subjected to the PermaCoat® thermal stratification coating process (hightemperature, in-line, multi-stage, multi-layer) including, as a minimum, asix-stage pre-treatment/wash (with zinc phosphate), an electrostatic spray application of an epoxy base, and a separate electrostatic sprayapplication of a polyester finish. The base coat shall be a thermosetting epoxypowder coating (gray in color) with a minimum thickness of of 2 mils (0.0508mm). The topcoat shall be a "no-mar" TGIC polyester powder coat finish with a minimum thickness of 2 mils (0.0508mm). The color shall be Black. The stratification-coated framework shall be capable of meeting the performance requirements for each quality characteristic shown in Table 1.
4. Completed gates shall be capable of supporting a 200 lb. load applied at midspan without permanent deformation..

B. Material:

1. Steel material for roll gate components (i.e. pales, rails, diagonals and uprights), shall be commercial steel with minimum yield strength of 45,000 psi (344 MPa).
2. Ornamental pale material shall be 3/4" square x 14 Ga. Tubing. Pale spacing shall be 6" o.c.. Material for toprails, uprights and diagonals rails shall be 2" square x 11 Ga. Material for the bottom rail shall be 2" x 4" x 11 Ga. Posts shall be 4" square x 11 Ga.

2.04 SWING GATES

A. Swing gates shall be fabricated using 1.75" x 14ga Forerunner double channel rail, 2" sq. x 11ga. gate ends, and 1" sq. x 14ga. pickets. Gates that exceed 6' in width will have a 1.75" sq. x 14ga. intermediate upright. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall also be joined by welding. Gusset plates will be welded at each upright to rail intersection. Cable kits will be provided for additional trussing for all gates leaves over 6'.

2.05 GATE MOTOR

A. Gate Motor shall be self-adjusting, no maintenance magnetic limits, partial-open feature, anti-tailgating feature, gate tracker reporting output and ports for plug-in loop detectors. DC Powered Convenience Open (Optional).

B. Two convenience outlets, fail-safe release (fail-secure optional), programming switches, built-in reset switch and built-in power on/off switch.

C. AC Drive:

1. The variable frequency drive unit shall allow for programmable speeds and programmable soft-start and soft-stop features.

D. Overload Protection:

1. Motors shall be protected against overload by either a thermal or a current sensing overload device.

E. Gear (Box) Reducer:

1. The self-enclosed gear-head gearbox shall be manufactured as a single unit, and shall consist of hardened steel, machine cut worm and mating bronze gear running in oil bath. Oil shall be #634 specialty oil with a fluid pour point of –44 degrees F. The gearbox shall perform the following functions:
   a. Adjustable Clutching Device.
   b. Manual disconnect by crank handle.

F. Gear Box Heater:

1. Operator shall include internal gearbox heater and a heater strip for the control box.

G. Drive – Chain:

1. A #100 roller chain shall be utilized. All chain brackets and required attachment hardware shall be supplied.

H. Manual Operation

1. A crank handle, located at ground level in the motor box, shall provide a two-step emergency procedure for manual operation:
   a. Unlock and open motor-box door.
   b. Fold out handle and crank gate opened or closed.

I. Limits: The operator shall be equipped with an integral limit system, providing accurate settings to control the open and close positions of the gate, and shall not be affected by manual operation or motor removal.

J. Control Circuit: U.L. listed operator shall have 5vdc controls.

K. Control wiring: The electrical contractor shall supply all exterior control wiring.

L. Audio Alarm: This alarm shall have a dual function.

1. The first function shall be as a warning prior to gate movement. When the motor control board recognizes a command, this alarm shall be activated three (3) seconds before the motor is energized and the gate begins to move. This shall be continuously activated while the gate is in motion.
2. For UL Class III operation only, the audio alarm shall be an entrapment notification alarm. This alarm shall sound as a result of a second activation of the external primary entrapment prevention device before an end limit (open or close) is reached. The pulsing rate of the alarm in the entrapment notification mode shall be faster than the pulsing rate when in the warning mode prior to gate movement.

M. Main Power Disconnect Switch and Wiring Compartment:

1. When this switch is in the OFF position, the main power shall be disconnected from the Variable Speed Drive, Motor Control Board and power transformer(s).

N. Speed: The gate operator speed shall be fully programmable allowing a maximum speed of 2.2 feet per second.

O. Transformer: Operators shall have an isolated low voltage (24V) secondary circuit supplied by a Class II transformer (minimum of 40va) to provide separate power for external control devices (not including external gate lock).

P. Auto Close Timer: The timer provides an automatic closure of the gate from the full open position, adjustable from 2 to 60 seconds.

2.06 GATE MOTOR HOUSING:

A. Water Resistant Motor Box

1. The motor box shall be constructed of 10-gauge sheet steel, hot-dip galvanized per ASTM 123, gasketed and located at ground level for easy maintenance.
2. Security Hinges and Tamper Resistant Security Screws
3. Security hinges and screws shall be furnished to secure operator enclosure components.

B. Motor Box Lock:

1. Motor box shall be locked with a prison dead bolt. Three (3) paracentric keys shall be provided per key code.

C. Compliant with UL 325 and 991. ETL listed.

1. To be compliant with UL 325 and industry safety guidelines, a secondary entrapment prevention device(s) is required to be installed with this gate operator.

D. Welded heavy-duty frame.

E. Heavy duty 10:1 gear reducer allows emergency manual operation without tools.

F. Fail secure lock standard (gate locks when power off).

G. Overload sensing system.

H. MVP "smart" radio receiver with FC antenna.

I. Built-in operator lock, auto close timer, maximum run timer and master/second capability.

J. Solid-state circuitry with diagnostic LED readout.

K. UL Listed for UL 325 (Class I-IV) for U.S. and Canada (120 VAC only) -HS (Class III-IV only).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Do not begin installation and erection before final grading is completed, unless otherwise permitted.

B. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces;

1. Remove all metal shavings from cut area.
2. Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color.
3. Follow manufacturer's recommendations and requirements.

C. Excavation: Drill or hand excavate (using post hole digger) holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than 4 times largest cross-section of post.
2. Unless otherwise indicated, excavate hole depths approximately 3" lower than post bottom, with bottom of posts set not less than 36" below finish grade surface.
3. Setting Posts: Center and align posts in holes 3" above bottom of excavation.
4. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.
5. Unless otherwise indicated, extend concrete footings 2" above grade and trowel to a crown to shed water.

D. Gates: Install gates plumb, level, and secure for full opening without interference. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacturer of the gate and shall be installed per manufacturer's recommendations.

E. Equipment in this section shall be installed in strict accordance with the company's printed instructions unless otherwise shown on the contract drawings.

F. The complete system shall be adjusted to assure it is performing properly. The system shall be operated for a sufficient period of time to determine that the system is in proper working order.

G. Ensure the owner is clear with regard to the safety points concerning the basic operational guidelines of the safety features of the gate operator system. These safety points are listed in the operator manual and must be read prior to system use

H. Test and Explain Safety Features:

1. Each system feature and device is a separate component of the gate system.
2. Read and follow all instructions for each component.
3. Ensure that all instructions for mechanical components, safety devices and the gate operator are available for everyone who will be using the gate system.
4. The warning signs shipped with the gate operator must be installed in prominent position on both sides of the gate.

END OF SECTION 02710

SECTION 02711
CHAIN LINK FENCING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of chain link fences, as indicated on drawings.

B. Under this section, the Contractor shall remove the existing gate and a portion of existing fencing as shown on the Drawings. New fencing shall be installed in the location as shown on the Drawings.

1.02 SECTION INCLUDES

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

B. Section 03300- Cast in-Place Concrete

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical data, and installation instructions for metal fencing, fabric, and accessories.

1.04 QUALITY ASSURANCE

A. Provide chain link fences as complete units controlled by a single source including necessary erection accessories, fittings, and fastenings.

PART 2 - PRODUCTS

2.01 GENERAL

A. Dimensions indicated for pipe, roll-formed, and H-sections are outside Dimensions, exclusive of coatings.

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include; but are not limited to, the following:

1. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
   a. Galvanized Steel Fencing and Fabric:
      i) Allied Tube and Conduit Corp.
      ii) American Fence Corp.
      iii) Anchor Fence, Inc.

b. Barbed Tape:
   i) American Fence Corp.
   ii) Man Barrier Corp.
   iii) Boundary Fence & Railing Systems, Inc.

2.02 STEEL FABRIC

A. Fabric: No. 9 gauge (0.148" t 0.005") size steel wires, 2" mesh, with top selvages knuckled for fabric 60" high and under, and both top and bottom selvages twisted and barbed for fabric over 60" high:

1. Furnish one-piece fabric widths for fencing up to 12' high.

B. Fabric Finish: Galvanized, ASTM A 392, Class I, with not less than 1.2 oz. zinc per sq. ft. of surface.

2.03 FRAMING AND ACCESSORIES

A. Steel Framework, General: Galvanized steel, ASTM A 120 or A 123, with not Less than 1.8 oz. Zinc per sq. ft. of surface.

1. Fittings and Accessories: Galvanized, ASTM A 153, with zinc weights per Table I.

B. End, Corner and Pull Posts: Minimum sized and weights as follows:

1. 8' – 10' fabric height, 2.375" OD steel pipe, 3.65 lbs per linear ft., or 3.5" x 3.5" roll-formed sections, 4.85 lbs per linear ft.
2. Over 6' fabric height, 2.875" OD steel pipe, 5.79 lbs per linear ft., or 3.5" x 3.5" roll-formed sections, 4.85 lbs per linear ft.
3. Either 2.875" OD aluminum pipe 2.0 lbs. per linear ft. or 2.50" square tubing, 2.9 lbs per linear ft.

C. Line Posts: Space 10' o.c. maximum, unless otherwise indicated, of following minimum sized and weights.

1. Up to 6' fabric height, 1.90" OD steel pipe, 2.70 lbs per linear ft. or 1.875" x 1.625" C-sections, 2.28 lbs per linear ft.
2. 8' to 10' fabric height, 2.375" OD steel pipe, 3.65 lbs per linear ft. or 2.25" x 1.875" H-sections, 2.64 lbs linear ft.
3. Over 8' fabric height, 2.875" OD steel pipe, 5.79 lbs per linear ft. or 2.25" x 1.875" H-sections, and 3.26 lbs per linear ft.
4. Up to 8' fabric height, either 2.375" OD aluminum pipe, 1.26 lbs per linear ft. or 2.25" x 1.875" H-section, 1.25 lbs per linear ft.
5. Over 8' fabric height, 2.875" OD aluminum pipe, 2.0 lbs per linear ft.

D. Top Rail: Manufacturer's longest lengths, with expansion type couplings, approximately 6" long, for each joint. Provide means for attaching top rail securely to each gate corner, pull and end post.

1. Steel fencing: 1.66" OD pipe, 2.27 lbs. per ft. or 1.625" x 1.25" roll-formed sections, 1.35 lbs. per ft.

E. Tension Wire: 7-gage, coated coil spring wire, metal and finish to match fabric.

1. Locate at bottom and top of fabric.

F. Wire Ties: 11 gauge galvanized steel, to match fabric core material.

G. Post Brace Assembly: Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for brace, and truss to line post with 0.375" diameter rod and adjustable tightener.

H. Post Tops: Provide weathertight closure cap with loop to receive tension wire or top rail; one cap for each post.

I. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross-section of 3/16" x 3/4". Provide one stretcher with bar for each gate and end post, and 2 for each corner and pull post, except where fabric is integrally woven into post.

J. Stretcher Bar Bands: Space not over 15" o.c., to secure stretcher bars to end, corner, pull, and gateposts.

K. Barbed Wire Supporting Arms: Manufacturer's standard barbed wire supporting arms, metal and finish to match fence framework, with provision for anchorage to posts and attaching 3 rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap and must be capable of withstanding 250 lbs. downward pull at outermost end. Provide following type:

1. Single 45-degree arm; for 3 strands barbed wire, one for each post.

L. Barbed Wire: 2 strand 12-1/2 gauge. Wire with 14 gauge. 4-point barbs spaced not more than 5" o.c.; metal and finish to match fabric.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Do not begin installation and erection before final grading is completed, unless otherwise permitted.

B. Excavation: Drill or hand excavate (using post hole digger) holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to minimum diameter recommended by fence manufacturer, but not less than 4 times largest cross-section of post.

2. Unless otherwise indicated, excavate hole depths approximately 3" lower than post bottom, with bottom of posts set not less than 36" below finish grade surface.

3. Setting Posts: Center and align posts in holes 3" above bottom of excavation.

4. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations.

5. Unless otherwise indicated, extend concrete footings 2" above grade and trowel to a crown to shed water.

C. Top Rails: Run rail continuously through post caps, bending to radius for curved runs. Provide expansion couplings as recommended by fencing manufacturer.

D. Center Rails: Provide center rails where indicated. Install in one piece between posts and flush with post on fabric side, using special offset fittings where necessary.

E. Brace Assemblies: Install braces as posts are plumb when diagonal rod is under proper tension.

F. Tension Wire: Install tension wires through post cap loops before stretching fabric and tie to each post cap with not less than 6 ga. galvanized wire. Fasten fabric to tension wire using 11 ga. Galvanized steel hog rings spaced 24" o.c.

G. Fabric: Leave approximately 2" between finish grade and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.

H. Stretcher Bars: Thread through or clamp to fabric 4" o.c., and secure to posts with metal bands spaced 15" o.c.

I. Barbed Wire: Pull wire taut and install securely to extension arms and secure to end post or terminal arms in accordance with manufacturer's instructions.

J. Tie Wires: Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing. Tie fabric to line posts, with wire ties spaced 12" o.c. Tie fabric to rails and braces, with wire ties spaced 24" o.c. Tie fabric to tension wires, with hog rings spaced 24"o.c.

K. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

END OF SECTION 02711

SECTION 02723
CATCH BASINS AND GRATE INLETS

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section shall consist of furnishing all labor, materials, and equipment for constructing complete all catch basins and headwalls at the locations shown on the Drawings or designated by the Engineer.

B. Related Work specified elsewhere:

1. Section 02200 - Earthwork.
2. Section 03100 - Concrete Formwork.
3. Section 03200 - Concrete Reinforcement and Dowelling.
4. Section 03300 - Cast-in-Place Concrete.

1.02 GENERAL

A. Catch basins and headwalls shall be constructed to the size, shape, and dimensions and at the locations shown on the Drawings or as directed by the Engineer.

B. Each catch basin and headwall shall be connected to a nearby storm sewer as indicated on the Drawings by means of concrete pipe and suitable fittings.

1.03 SUBMITTALS

A. Submit the following in accordance with the requirements of the General Conditions of the Contract Documents:

1. Product information on materials in Part 2 of this Section.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete, cement, sand, and water shall conform to the applicable requirements of Section 03300 Cast-In-Place Concrete. Concrete shall be 3,000 psi.

B. Steel reinforcement shall conform to the requirements of Section 03200 Concrete Reinforcement and Dowelling.

C. Precast concrete structure shall conform to the requirements of ASTM C476.

D. Unless otherwise indicated, grate inlets shall be provided with cast iron grate as shown in the Drawings. All castings shall be true to pattern in form and dimensions, free from faults, sponginess, cracks, blowholes and other defects affecting their strength. Bearing surfaces between cast frames and gratings shall be machined, fitted together, and match marked to prevent

rocking. All castings shall be thoroughly cleaned and painted or coated with a coal tar pitch varnish.

PART 3 - EXECUTION

3.01 EXCAVATION

A. Excavation shall be in accordance with the requirements of Section 02200 Earthwork.

3.02 CONCRETE CONSTRUCTION

A. Forms for concrete shall be constructed of such materials and in a manner meeting the requirements of Section 03100 Concrete Formwork.

B. Unless otherwise indicated on the Drawings, all Portland cement concrete structures or parts of structures shall be constructed of concrete meeting the requirements of Section 03300 Cast-In-Place Concrete.

C. Any surface plastering or "parging" shall be done with Portland cement and sand mix. All grouted slopes and inverts shall also use this mix.

3.03 INVERTS

A. All inverts shall be of concrete meeting the requirements of Section 03300 Cast-In-Place Concrete, and shall conform to the shape indicated on the Drawings or as directed by the Engineer. All pipe sizes, weir sizes, and invert elevations shall be as shown on the Drawings.

3.04 OUTLET PIPE

A. Each piece of pipe and special fitting shall be carefully inspected before it is placed and no defective pipe shall be laid in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the groove uphill. No pipe shall be laid except in the presence of an inspector representing the Engineer. Trench bottoms found to be unsuitable for foundations after pipe laying operations have started shall be corrected and brought to exact line and grade with approved compacted materials where necessary.

B. Pipe placed in the walls for outlet connections shall extend through the wall and beyond the outside surface of the walls to allow for connections. The end of the pipe being placed shall be rounded and flush with the inside face of the wall. Masonry shall be carefully constructed around the pipe so there will be no leakage around the outer surface.

3.05 CASTINGS

A. Cast iron frames shall be set accurately to line and finished elevation so that subsequent adjustments will not be necessary.

B. Frames shall be set in full cement mortar beds and set in place to match the finished concrete surface in paved areas.

3.06 CLEANING

A. After completion of the catch basin, the interior shall be thoroughly cleaned of all excess materials, the grating placed and all unused materials, tools, equipment and debris removed from the area.

B. After the masonry and frames have had sufficient time to set, but in no case less than 24 hours after placement, the space around the catch basin shall be backfilled and compacted to the required grade.

C. Final cleaning shall be performed in accordance with the requirements of the "General Conditions" of the Contract Documents.

END OF SECTION 02723

SECTION 02730
SEWERS, STORM DRAINS AND ACCESSORIES

PART 1 - GENERAL

SCOPE

A. The Work described in this Section includes furnishing all labor, materials, and equipment required for a complete and operable installation of all sewers, storm drains and accessories. All gravity sewers, storm drains, and accessories shall be installed, adjusted, tested and placed in operation in accordance with these Specifications and the manufacturer's recommendations and as shown on the Drawings.

B. Supply all products and perform all work in accordance with applicable American Society for Testing and Material (ASTM), American Water Works Association (AWWA), American National Standards Institute (ANSI), or other recognized standards. Latest revisions of all standards are applicable.

C. Pipe not specified in this section is specified in Section 15060 Piping and Appurtenances.

1.02 QUALIFICATIONS

A. If requested by the Engineer, submit evidence that manufacturers have consistently produced products of satisfactory quality and performance for a period of at least two (2) years.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

B. The Contractor shall submit proposed methods, equipment, materials, and sequence of operations for sewer construction. The Contractor shall plan operations to minimize disruption of utilities and to occupied facilities on adjacent property.

C. The Contractor shall submit manufacturers' instructions indicating special procedures required to install products specified.

D. Submit shop drawings to the Engineer for review showing a complete laying plan of all pipe, including all fittings adapters, valves, flumes, vortex inserts, and specials along with the manufacturer's drawings and specifications indicating complete details of all items. The pipe details shall include stationing, pipe class or design and supporting computations; and laying schedule which specifies pipe class, class coding, station limits, and transition stations for various pipe classes. The above shall be submitted to the Engineer for review before fabrication and shipment of these items. The locations of all pipes shall conform to the locations indicated on the Drawings.

1.04 TRANSPORTATION AND HANDLING

A. Unloading: Furnish equipment and facilities for unloading, handling, distributing and storing pipe, fittings, valves, and accessories. Make equipment available at all times for use in unloading.

B. Do not drop or dump materials. Any materials dropped or dumped will be subject to rejection without additional justification.

C. Handling: Handle pipe, fittings, valves and accessories carefully to prevent shock or damage. Handle pipe by rolling on skids, forklift, or front loader. Do not use material damaged in handling.

1.05 STORAGE AND PROTECTION

A. Store all pipe which cannot be distributed along the route. Make arrangements for the use of suitable storage areas.

B. Stored materials shall be kept safe from damage. The interior of all pipes, fittings, and other appurtenances shall be kept free from dirt or foreign matter at all times.

C. Pipe shall be stored per the manufacturer's recommendations.

D. Store joint gaskets in a cool location, out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

1.06 QUALITY ASSURANCE

A. Product manufacturers shall provide the Engineer with written certification that all products furnished comply with all applicable provisions of these Specifications.

PART 2 - PRODUCTS

2.01 PIPE

A. Ductile Iron Pipe:

1. Ductile iron pipe shall be utilized as shown on the Drawings.
2. Ductile iron pipe shall be manufactured in accordance with AWWA C151. All pipe, except specials, shall be furnished in nominal lengths of 18 to 20 feet. Sizes will be as shown on the Drawings. All pipe shall have a minimum pressure rating as indicated in the following table, and corresponding minimum wall thickness, unless otherwise shown:

Pipe Sizes (inches)	Pressure Class (psi)
4 - 12	350
14 - 18	350
20	300
24	250
30 - 54	200
60 - 64	200

3. Flanged pipe minimum wall thickness shall be equal to Special Class 53.
4. All ductile iron pipe fittings shall have a double cement-mortar lining conforming to the

requirements of ANSI A21.4 (AWWA C104) and a standard bituminous outer coating unless shown on the Drawings or directed by the Engineer.

5. Fittings shall be ductile iron and shall conform to AWWA C110 or AWWA C153 with a minimum rated working pressure of 250 psi.

6. Joints: Unless shown on the Drawings or specified otherwise, joints shall be push-on. Joints shall conform to AWWA C111. Flanged joints shall conform to AWWA C115.

7. Provide the appropriate gaskets for joints. Gaskets for flange joints shall be made of 1/8-inch thick, cloth reinforced rubber; gaskets may be ring type or full face type.

8. Provide the necessary bolts for mechanical and flange connections. Bolts for flange connections shall be steel with American Regular unfinished square or hexagon heads. Nuts shall be steel with American Standard Regular hexagonal dimensions, all as specified in ANSI B17.2. All bolts and nuts shall be threaded in accordance with ANSI B1.1, Coarse Thread Series, Class 2A and 2B fit. Mechanical joint glands shall be ductile iron.

9. Wall Pipes
   a. Where piping passes through concrete structures, furnish and install wall pipes or other provisions as specifically shown on the Drawings. Wall sleeves shall be accurately located and securely fastened into position before concrete is poured.
   b. Wall Pipes
      i) Wall pipes shall be either statically cast iron with integral waterstop collar or centrifugally cast ductile iron with a continuously welded waterstop collar. The waterstop collar shall be capable of withstanding a thrust force caused by a 250 psi dead end load from either direction on that size pipe. Wall pipes shall be furnished uncoated on the outside and cement lined on the inside. Unless specified or shown otherwise for a specific situation, wall pipes shall be flange-flange type.
      ii) Wall pipes shall be cast and/or fabricated and lined in one manufacturer's facilities and delivered to the job site ready for use.

10. Acceptance: Acceptance will be on the basis of the Engineer's inspection and the manufacturer's written certification that the pipe was manufactured and tested in accordance with the applicable standards.

B. Steel Pipe: Steel pipe shall be provided as specified in Section 15060 Piping and Appurtenances.

C. Reinforced Concrete Pipe:

1. Pipe shall be bell and spigot reinforced concrete pipe conforming to ASTM C76. Class III pipe Wall B, unless otherwise shown.

2. In addition, the pipe and materials shall meet the following requirements:
   a. Concrete shall have a minimum compressive strength of 5,000 psi for Class III.
   b. Cement shall meet the requirements of ASTM C 150, Type II.
   c. Absorption shall not exceed six percent when tested in accordance with ASTM C 497.

3. Reinforced concrete pipe shall be supplied in lengths of at least eight feet, where applicable.

4. Joints: Pipe shall have concrete and rubber O-ring gasket type joints conforming to ASTM C 361. A rectangular groove shall be supplied in the spigot end to receive the rubber O-ring gasket, and it shall be so formed that when the joint is complete the gasket will be deformed to a rectangular shape and confined on all four sides. Bell and spigot surfaces shall be

accurately formed and smooth to provide a close sliding fit with a nominal clearance of 1/16-inch.

5. Fittings and Specials: Reinforced concrete pipe fittings and specials shall meet all requirements for reinforced concrete pipe, including materials of construction, structural strength, linings, and joints. Provide couplings for connection to pipe of different materials as shown on the Drawings and as specified herein.

6. Pipe Couplings:
   a. Unless shown or specified otherwise, pipe couplings shall be carbon steel and slip-on, gasketed type, with a diameter to properly fit the pipe.
   b. Couplings shall be Depend-O-Lok EXE as manufactured by Brico Industries, Inc. or equal.

7. Acceptance:
   a. Acceptance of pipe shall be on the basis of plant load-bearing tests for the load to produce 0.01-inch crack and the ultimate strength of the pipe, material tests, and inspection of manufactured pipe for visual defects and imperfections as described in Paragraph 5.1.1, Acceptance on the Basis of Plant Load-Bearing Tests,Material Tests, and Inspection of Manufactured Pipe for Visual Defects and Imperfections, of ASTM C 76.
   b. Provide results of tests on pipe, pipe materials, joint material, and made-up joints performed by an independent testing laboratory approved by the Engineer. Include materials, absorption, crushing, and hydrostatic leakage tests on pipe of each size in accordance with applicable specifications.
   c. Each length of pipe shall be stamped by a regular employee of the approved testing laboratory.
   d. Inspect pipe after delivery for laboratory stamp, shape, cracks, uniformity, blisters and imperfect surfaces, hammer test, damaged ends, and gasket grooves. Do not accept or use pipe with repaired or patched gasket grooves or shoulders. Any pipe repaired or patched is subject to rejection by the Engineer.

8. No pipe shall be shipped before it has been cured for a minimum of 14 days.

D. PVC pipe:

1. This specification covers polyvinyl chlorinated (PVCpipe for gravity sewer and surface water applications. This product is intended for gravity applications where the operating temperature will not exceed 140°F.

2. Pipe material shall be manufactured from virgin rigid PVC (polyvinyl chloride) vinyl compounds meeting requirements of ASTM D 1784, classification 12454 or 12364.

3. Pipe shall be bell and spigot pipe conforming to ASTM D 3034 with a side dimension raito of SDR 35 with a stiffness value of 46, unless otherwise shown.

4. Joints: Provide pipe with integral bells with locked-in gaskets meeting requirements of ASTM D 3212 and F 477. Furnish pipe in minimum lengths of 14 feet.

5. Fittings and Specials: PVC pipe fittings and specials shall meet all requirements for PVC pipe, including materials of construction, structural strength, and joints. Provide couplings for connection to pipe of different materials as shown on the Drawings and as specified herein.

2.02 MANHOLES AND PRECAST CONCRETE PRODUCTS

A. Precast Concrete Sections:

1. Precast concrete sections shall meet the requirements of ASTM C 478 and ASTM C 913 for rectangular precast concrete products. The minimum compressive strength of the concrete in precast sections shall be 4,000 psi.
2. The minimum wall thickness shall be one-twelfth of the inside diameter of the base, riser, or the largest cone diameter. Additionally, the wall thickness shall be sufficient for the proper installation of the rubber boots.
3. Transition slabs which convert bases larger than four feet in diameter to four foot diameter risers shall be designed by the manhole manufacturer to carry the live and dead loads exerted on the slab.
4. Seal joints between precast sections by means of rubber O-ring gaskets or flexible butyl rubber sealant. Butyl rubber sealants shall meet the requirements of AASHTO M-198. Sealant shall be pre-formed type with a minimum nominal diameter of 1-inch. Butyl rubber sealant shall be equal to Kent Seal No. 2 or Concrete Sealants CS202.

B. Iron Castings:

1. Cast iron manhole frames, covers and steps shall meet the requirements of ASTM A 48 for Class 30 gray iron and all applicable local standards. All castings shall be tough, close grained, smooth, and free from blow holes, blisters, shrinkage, strains, cracks, cold shots, and other imperfections. No casting will be accepted which weighs less than 95 percent of the design weight. Shop drawings must indicate the design weight and provide sufficient dimensions to permit checking. All castings shall be thoroughly cleaned in the shop and given two coats of approved bituminous paint before rusting begins.
2. Manhole frames and covers shall be City of Atlanta standard as shown on the Drawings.
3. All frames and covers shall have machined horizontal bearing surfaces.
4. All manholes shall be standard frames and covers except unless shown otherwise.
5. Watertight covers shall be bolt-down type and shall be equipped with four 1/2-inch stainless steel bolts and a 1/8-inch neoprene or rubber O-ring gasket. Covers shall be rotatable and interchangeable. Bolt holes shall be bored through so that debris entering the bolt hole will fall into the manhole. Bolt holes shall have the full 360 degree circle within the cover's radius when bored through the cover.

C. Manhole Steps: Manhole steps of polypropylene molded around a steel rod equal to products of M.A. Industries shall be used.

D. Rubber Boots: Provide preformed rubber boots and fasteners equal to those manufactured by Kor-N-Seal or Press Seal Gasket Corporation.

PART 3 - EXECUTION

3.01 LOCATION AND GRADE

A. The Drawings show the alignment and grade of the sewer and drain and the position of manholes and other appurtenances. The slope shown on the Drawings and/or called for in the Specifications is the slope of the invert of the pipe.

B. The Contractor shall perform all surveys necessary for the establishment of the horizontal and vertical alignment of the sewer.

C. Reference Points:

1. The Contractor shall take all precautions necessary, which includes, but is not necessarily limited to, installing reference points.
2. The Contractor shall give the Engineer reasonable notice that reference points are set. The reference point locations may be verified by the Engineer.
3. The Contractor shall be responsible for any damage done to reference points, base lines, center lines and temporary bench marks, and shall be responsible for the cost of re-establishment of reference points, base lines, center lines, and temporary bench marks as a result of the Contractor's operations.

3.02 LAYING AND JOINTING PIPE AND ACCESSORIES

A. Lay all pipe and fittings to accurately conform to the lines and grades shown on the Drawings.

B. Pipe Installation:

1. Proper implements, tools and facilities shall be provided for the safe performance of the Work. All pipe, fittings and valves shall be lowered carefully into the trench by means of slings, ropes, or other suitable tools or equipment in such a manner as to prevent damage to sewer materials, protective coatings, and linings. Under no circumstances shall sewer materials be dropped or dumped into the trench.
2. All pipe, fittings, valves and other appurtenances shall be examined carefully for damage and other defects immediately before installation. Defective materials shall be marked and held for inspection by the Engineer, who may prescribe corrective repairs or reject the materials.
3. All lumps, blisters and excess coating shall be removed from the socket and plain ends of each pipe, and the outside of the plain end and the inside of the bell shall be wiped clean and dry and free from dirt, sand, grit, or any foreign materials before the pipe is laid. No pipe which contains dirt shall be laid.
4. Foreign material shall be prevented from entering the pipe while it is being placed in the trench. No debris, tools, clothing, or other materials shall be placed in the pipe at any time.
5. As each length of pipe is placed in the trench, the joint shall be assembled and the pipe brought to correct line and grade. The pipe shall be secured in place with approved backfill material.

6. Lay pipe with the bells up the grade.

7. Applying pressure to the top of the pipe, such as with a backhoe bucket, to lower the pipe to the proper elevation or grade shall not be permitted.

C. Expediting of Work: Excavate, lay the pipe, and backfill as closely together as possible. Do not leave unjointed pipe in the trench overnight. Backfill and compact the trench as soon as possible after laying and jointing is completed. Cover the exposed end of the installed pipe each day at the close of work and at all other times when work is not in progress. If necessary to backfill over the end of an uncompleted pipe or accessory, close the end with a suitable plug.

D. Joint Assembly:

1. Push-on, mechanical and flange type joints shall be assembled in accordance with the manufacturer's recommendations.

2. The Contractor shall internally inspect each pipe joint to ensure proper assembly after the pipe has been brought to final alignment.

E. Pipe Coupling Installation:

1. Pipe couplings shall be installed where shown on the Drawings. Couplings shall be installed in strict conformance with the manufacturer's instructions.

2. Pipe ends shall be cleaned, brushed or filed to produce a mating surface that is free of dirt, rust, chuck marks, mill scores, dents, burrs, or other foreign substances that would impede proper gasket seating.

3. A lubricant recommended by the coupling manufacturer shall be used in seating all gaskets.

F. Cutting Pipe:

1. Cut the pipe per the manufacturer's written recommendations.

2. Remove all burrs and smooth the end before jointing.

3. The Contractor shall cut the pipe and bevel the end, as necessary, to provide the correct length of pipe necessary for installing the fittings, valves, accessories, and closure pieces in the correct location.

3.03 MANHOLE AND PRECAST CONCRETE PRODUCT CONSTRUCTION

A. Construct manholes as shown on the Drawings.

B. Precast Concrete: Handle sections carefully to prevent cracking or chipping. Provide uniform bedding of the bottom section to prevent uneven loading. Install gaskets and joint sealants in accordance with manufacturer's recommendations to produce a watertight structure.

C. Pipe Connections: Seal the void between the pipe and the manhole with brick and mortar on both the inside and outside.

1. Pipe 36-Inch Diameter and Less: Connect pipe to manhole utilizing rubber boots unless shown otherwise on the Drawings.

2. If preformed openings must be enlarged or altered, or if new openings must be made in the field, minimize the amount of material removed to provide closely matched surfaces for grouting.

D. Inverts: Form channels as shown on the Drawings, rounded, and troweled smooth. Maintain consistent grade through the invert.

E. Seal all manhole joints and lift holes, both inside and out, with grout. Seal between precast sections, this is in addition to manufacturer's recommended gaskets and joint sealants.

F. Invert Elevations: The invert elevations shown on the Drawings shall be for the invert at the centerline of the manhole. Prior to setting the laser or other vertical alignment control system for the sewer or drain upstream of the manhole, the Contractor shall verify the elevation of the sewer or drain installed at the manhole. Should the elevation differ from that shown on the Drawings, the Contractor shall take the following corrective action:

1. If the sewer or drain is laid at negative grade, the Contractor shall remove and reinstall the sewer or drain at the correct grade at no additional cost to the Owner.

   If the sewer or drain is laid at a grade less than that shown on the Drawings, thus reducing the sewer's capacity, the Owner may require the sewer to be removed and relaid at the correct grade at no additional cost to the Owner. As a minimum, the grade to the next upstream manhole shall be adjusted such that the next upstream manhole shall be set at the correct elevation.

2. If the sewer or drain is laid at a grade greater than that shown on the Drawings, and if the Contractor can show that there are no conflicts with upstream existing utilities or obstructions, the Contractor shall adjust the grade of the next upstream manhole such that the next upstream manhole shall be set at the correct elevation. If such an adjustment, in the Engineer's opinion, is substantial, the grade adjustment shall be spread over multiple sections of the sewer. If such an adjustment, in the Owner's opinion, significantly reduces the sewer's capacity, the Owner may require the Contractor to remove and relay at no additional cost to the Owner that portion of the sewer laid at the improper grade.

G. Manholes shall be constructed such that their walls are plumb.

3.04 INSPECTION AND TESTING

A. Clean and test lines before requesting final acceptance. Where any obstruction is met, clean the sewers by means of rods, swabs, or other instruments. When directed by the Engineer, flush out lines and manholes before final inspection.

B. Alignment: Pipe lines shall be straight and show a uniform grade between manholes. Straight alignment shall be checked by either using a laser beam or lamping. Each segment between manholes must show at least 90 percent of the full pipe circle visible when looking from manhole to manhole. If unacceptable sags are detected, the pipe must be taken up and relaid. Correct any discrepancies discovered during inspection.

C. Watertightness: All sewers and drains constructed shall be tested for watertightness to the maximum extent feasible. Tests shall be performed on all new sewers and drains constructed as indicated below, except for those new sewers constructed which have active services tied into them as the pipe is being installed. In such cases the watertightness of the sewers less than or equal to 24-inches shall be based low pressure air test, and for sewers 30-inches and larger based on the individual joint test as specified below. All visible leaks shall be repaired by the Contractor at no additional cost to the Owner.

D. Tests

1. Low-Pressure Air Test of Sewer and drain diameters less than or equal to 24-inches:
   a. Prior to air testing, the section of sewer between manholes shall be thoroughly cleaned and may be wetted. Immediately after cleaning or while the pipe is water soaked, the sewer shall be tested with low-pressure air. At the Contractor's option, sewers may be tested in lengths between manholes or in short sections (25 feet or less) using inflatable balls pulled through the line from manhole to manhole. Air shall be slowly supplied to the plugged sewer section until internal air pressure reaches approximately 4.0 psi. After this pressure is reached and the pressure allowed to stabilize (approximately two to five minutes), the pressure may be reduced to 3.5 psi before starting the test. If a 1.0 psi drop does not occur within the test time, then the line has passed the test. If the pressure drops more than 1.0 psi during the test time, the line is presumed to have failed the test, and the Contractor will be required to locate the failure, make necessary repairs, and retest the line. Minimum test time for various pipe sizes is as follows:

Nominal Pipe Size (Inches)	Time (Min/100 feet)
6	5.7
8	7.6
10	9.4
12	11.3
15	14.2
18	17.0
21	19.8
24	22.8

   b. Required test equipment, including inflatable balls, braces, air hose, air source, timer, rotameter as applicable, cut-off valves, pressure reducing valve, 0-15 psi pressure gauge, 0-5 psi pressure gauge with gradations in 0.1 psi and accuracy of + two percent, shall be provided by the Contractor. Testing equipment shall be equal to Cherne Air-Loc Testing Systems.
   c. The Contractor shall keep records of all tests made. Copy of such records will be given to the Engineer. Such records shall show date, line number and stations, operator, and such other pertinent information as required by the Engineer.
   d. The Contractor is cautioned to observe proper safety precautions in performance of the air testing. It is imperative that plugs be properly secured and that care be exercised in their removal. Every precaution shall be taken to avoid the possibility of over-pressurizing the sewer line.

2. Individual Joint Test for sewers 30-inches in diameter and larger:
   a. Each pipe joint shall be tested with an Ultrasonic Transmitter and Detector during installation. The Contractor shall submit the test procedure for approval.
3. All manholes shall be vacuum tested per ASTM C 1244 or hydraulically tested to leak less than ¼ inch of level over a period of 24 hours.

END OF SECTION 02730

SECTION 02823
ALUMINUM LOUVER FENCING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Ornamental fixed louver modular fencing panels fabricated with extruded aluminum louvers and flat aluminum bars including extruded aluminum fence posts and aluminum louver gates.

1.02 RELATED SECTIONS:

A. Section 03300 - Cast-in-Place Concrete: Concrete footings for support of fence posts.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:

1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
2. ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
3. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
4. ASTM D822 - Tests on Paint and Related Coatings Using Filtered Open-Flame Carbon-Arc Exposure Apparatus.
5. ASTM D1794 - Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
6. ASTM D3363 - Test Method for Film Hardness by Pencil Test.

1.04 SUBMITTALS

A. Provide in accordance with General Conditions requirements for submittal procedures:

1. Product data for components and accessories.
2. Shop drawings showing layout, dimensions, spacing of components, interface with electric gate operator, and anchorage and installation details.
3. Sample: 8 by 10 inches minimum size sample of fence panel illustrating design, fabrication workmanship, and selected color coating.
4. Copy of warranty specified in Paragraph 1.4 for review by Architect.

1.05 WARRANTY

A. Provide in accordance with General Conditions:

1. 20 years warranty for factory finish against cracking, peeling, and blistering under normal use.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Ametco® Manufacturing Corporation, 4326 Hamann Parkway, P.O. Box 1210, Willoughby,Ohio 44096; 800-362-1360, or equal. Products of Ametco Manufacturing Corporation is the basis of design and approved for use.

2.02 MATERIALS

A. Extruded aluminum: ASTM B221, Alloy 6063, Temper T-6.

B. Sheet aluminum: ASTM B209 6063, Temper T-6.

C. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, and water reducing and plasticizing additives.

2.03 FENCE SYSTEM

A. Phoenix: Inclined, extruded aluminum 1/2 x 4 inch (13 by 104 mm) tubular louver blades installed horizontally and spaced to provide either 80 or 100 percent direct visual screening.

B. Type: Ornamental fencing system consisting of horizontal, fixed louver, modular fence panels fabricated with extruded aluminum framing bars and supported by extruded aluminum fence posts; Phoenix Aluminum Fixed Louver Fencing as manufactured by Ametco® Manufacturing Corporation.

C. Fence panel:

D. Fixed louver bars: Two rows of Extruded aluminum tube,1/2 inch x 4 inches wide, spaced at 4 inches for 100 percent visual screening.

E. Cross bars: 1/2 by 1/8 inch flat bars welded perpendicular to back side of louver bars and spaced at 18 inches

F. Panel height: 62-3/8 inches.

G. Panel width: 64-21/32 inches.

1. Posts: Extruded aluminum solid shapes.
   a. Size: 2-1/2 by 5/16 inch.
   b. Length: as required

2.04 GATES

A. Provide gates of type and size indicated on Drawings. Equip gates with manufacturer's standard hardware as required for complete functional operation.

B. Type: Hinged swinging single or double gate.

1. Construction: Welded frame fabricated from extruded aluminum tubing with aluminum fixed louver panels to match fencing material.
2. Nominal size: as shown on drawings.
3. Hardware:
   a. Hinges: Size and type as determined by manufacturer. Provide 2 hinges for each leaf up to 6 feet high and 1 additional hinge for each additional 24 inches in height or fraction thereof.
   b. Latch: 3/4 inch diameter slide bolt to accommodate padlock.
   c. For double gates provide pad lockable, 5/8 inch diameter center cane bolt assembly and strike.
4. Type: V-wheeled rolling gates.
   a. Construction: Welded frame fabricated from extruded aluminum tubing with aluminum fixed louver panels to match fencing material. Frame configuration shall be as indicated on Drawings and approved shop drawings.
   b. Nominal size:
      i) Gate opening: as shown on drawings.
   c. Support posts: Pair of tubular aluminum posts with solid cap. See drawings for size.
   d. Rolling mechanism: Steel wheels with V-shaped edge groove and 6 inches diameter, mounted to gate frame and riding on ground set V-track. Assembly braced at top by adjustable guide wheels mounted with brackets to support posts.
5. Type: Cantilevered horizontal sliding gate.

2.05 ACCESSORIES

A. Fasteners: Stainless steel bolts of type, size, and spacing as recommended by fence manufacturer for specific condition.

B. For exposed locations, provide anti-intruder bolts consisting of cup head bolt and nut with clamping hexagon such that tightening shears hexagon and render bolt impossible to release.

2.06 FACTORY FINISH

A. Aluminum fence panels and posts shall receive polyester powder coating. Large gate panels shall be coated with 2-part polyurethane coating.

B. Polyester powder coating: Electrostatically applied colored polyester powder coating heat cured to chemically bond finish to metal substrate.

1. Minimum hardness measured in accordance with ASTM D3363: 2H.
2. Direct impact resistance tested in accordance with ASTM D2794. Withstand 160 inch-pounds.
3. Salt spray resistance tested in accordance with ASTM B117: No undercutting, rusting, or blistering after 500 hours in 5 percent salt spray at 95 degrees F and 95 percent relative humidity and after 1000 hours less than 3/16 inch undercutting.

4. Weatherability tested in accordance with ASTM D822: No film failure and 88 percent gloss retention after 1 year exposure in South Florida with test panels tilted at 45 degrees.
5. Polyurethane coating: 1.0 mil dry film thickness of coating of test panel cured 30 minutes at 180 degree F and aged 14 days shall resist the following test conditions without failure:
   a. 5 percent salt spray for 500 hours.
   b. 100 percent relative humidity for 1000 hours.
   c. Water immersion for 100 hours.
   d. 20 double rubs with cloth saturated with either lacquer thinner, acetone, MEK, gasoline, xylene.
   e. Exposure to lubricating oils, hydraulic fluids, and cutting oils.
   f. 16 cycles of 24 hours at 100 percent humidity, 24 hours at 10 degrees F, and 24 hours at 77 degrees F.
   g. Hardness: H to 2H.
   h. Flexibility: 1/8 inch
6. Color: Selected by Architect from manufacturer's Custom color range.

PART 3 - EXECUTION

3.01 PREPARATION

A. Prior to fabrication, field verify required dimensions.

B. Coordinate fence and gate installation with provision of gate operator to ensure proper power supply and that conduit and wiring are concealed.

C. Cast concrete footings in accordance with Section 03300 - Cast-in-Place Concrete as detailed on Drawings and approved shop drawings.

1. Minimum footing diameter:
   a. Terminal and gate posts: 12 inches.
   b. Intermediate line posts: 10 inches.
   c. Allow 12 inches minimum embedment of posts.
   d. Allow 6 inches minimum concrete beneath post bottom.
2. Provide setting holes for embedment of fence posts. Hole shall be 2 inches minimum greater than post width.

3.02 INSTALLATION

A. Install fencing in accordance with manufacturer's installation instructions and approved shop drawings.

B. Install fence posts plumb and level by setting post in hole cast or drilled in concrete and grouting solid. Temporarily brace fence posts with 2 by 4 wood supports until concrete is set.

C. Do not installed bent, bowed, or otherwise damaged panels. Remove damaged components from site and replace.

D. Secure fence panels with stainless steel anti-intruder bolts to fence posts after posts have been set in footings.

E. Gates:

1. Install gates and adjust hardware for smooth operation.
2. Provide concrete center foundation depth and drop rod retainers at center of double swinging gate openings.
3. Provide concrete surface for length of operation of V-wheeled rolling gate. Anchor track to concrete with countersunk fasteners.
4. After installation, test gate and operator. Open and close a minimum of five times. Correct deficiencies and adjust.
5. Touch-up damaged finish with paint supplied by manufacturer and matching original coating.

END OF SECTION 02823

SECTION 02900
LANDSCAPE

PART 1 - GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment, and incidentals required for clearing and grubbing of existing vegetation and weed eradication in areas where new plantings are to be provided, bed preparation as specified herein and shown on the Drawings, providing trees, plants and ground covers where specified, maintenance of the work prior to Final Acceptance, repair and replacement of damaged landscape work, and all activities designated on the Project Schedule.

1.02 QUALITY OF WORK AND MATERIALS

A. The Contractor shall have minimum five years successful experience in the field and shall furnish all materials and perform all work in accordance with these Specifications, Drawings, and instructions provided by the Landscape Architect or Owner's representative hereafter also referred to as Landscape Architect. The work shall include everything shown on the Drawings and required by the Specifications and everything to which in the judgment of the Landscape Architect is incidental to what is shown on the Drawings or required by the Specifications. Workmanship and materials shall be of the best quality and shall be in strict accordance with the intention of the Drawings, Specifications and samples. The Contractor shall cooperate with the Landscape Architect so that no error or discrepancy in the Drawings or Specifications shall cause defective or inappropriate materials to be used or poor workmanship to be allowed and so that the work may proceed in the most efficient and effective manner.

1.03 WEATHER

A. Plant only during weather conditions favorable to landscape construction and to the health and welfare of plants. Contractor to notify Landscape Architect immediately if directed to commence planting operations in conditions detrimental to plant health.

1.04 PERCOLATION TEST

A. The Contractor shall be responsible for determining existing sub-surface drainage conditions for areas to be planted or sodded. The Contractor shall include as a part of his proposal the cost for making the following percolation tests in any area where he is uncertain about adequate sub-surface drainage. Report unacceptable areas to Landscape Architect/Owner's Representative for instructions.

B. Percolation tests shall be made as follows:

1. Wait at least 24 hours after rain and dig test pit 12-inches square or 13-1/2- inches in diameter to depth of bottom of plant bed and remove all loose soil. (If standing water is visible, notify Landscape Architect).
2. Quickly fill pit bottom with 6 inches (approximately 3-1/4 gallons) of water.
3. Record length of time from filling until disappearance of water and divide number of minutes by 6 to give average time of 1-inch fall.

4. Compare 1-inch time with following table:
   a. 1 inch in 0 - 3 minutes indicates rapid absorption
   b. 1 inch in 3 - 5 minutes indicates medium absorption
   c. 1 inch in 5 - 30 minutes indicates slow absorption
   d. 1 inch in over 60 minutes indicates impervious soil
5. In plant bed areas where sub-soil conditions do not percolate or the bed is enclosed by pavement, curbs, walks or other hard construction, the Contractor shall install a 4-inch drain line that allows the sub-surface of the bed to drain to the storm system or out to day light on the nearest slope.

1.05 SUBMITTALS

A. It is the responsibility of the Contractor, before ordering or purchasing materials, to provide two photographs of each tree type with description to the Landscape Architect for review and approval. Contractor shall tag and deliver trees that match approved sample photographs. Landscape Architect will decide final approval of all plant material on site.

B. The Contractor is to submit certification tags from trees, shrubs, seed, and sod verifying type and purity.

C. Materials: Samples of materials as listed below shall be submitted for inspection on the job site, or as otherwise determined by the Landscape Architect.

Material	Sample
Pine Straw	1 Bale
Topdressing Sand	1 Cup
Soil Amendment - Pine Bark Humus	1 Bag
Topsoil	1 Bag
Lime – pelletized	1 Bag
Fertilizer (as specified by soil tests for turf)	1 Bag
Seed (as specified on erosion plan)	1 Bag
Pre-emergent Herbicide	Brand name and contents

D. Soils test results: It is the responsibility of the contractor to obtain soils tests and submit results to the Landscape Architect with specific recommendations for soil amendments and fertilization as indicated by the soils tests. Where areas vary significantly in soil composition, slope, or watering schedule, separate tests are required for each area. The Contractor must specify the type of grass, trees and other plants to be installed in each area to be tested. Fertilizer specified for turf grasses will be applied at planting time. The Owner shall be informed of fertilizer specified for trees so that application can be made after the initial growing season when slow-release fertilizer in the root ball has been exhausted.

E. Plants shall be subject to inspection and approval at the place of growth, or upon delivery to the site, as determined by the Landscape Architect, for quality, size and variety. Such prior approval will not impair the right of inspection and rejection at the site during progress of the work or after completion, for size and conditions of balls or roots, latent defects or injuries. Rejected plants shall be removed immediately from the site. Notice requesting inspection should be submitted by the Contractor at least one week prior to anticipated date.

F. Typical samples shall be furnished from each separate source of supply. Approved samples shall be stored on the site and protected until furnishing of material is completed. Plant samples may be planted in permanent positions, but labeled as samples.

G. Upon approval of samples by the Landscape Architect, delivery of materials may begin.

H. Samples: Submit.

1.06 PLANT MATERIAL SIZE AND MEASUREMENT

A. Plants shall be measured when branches are in their normal position.

B. Shrubs shall meet the size requirements stated in the Plant List. The measurements are to be taken from the ground level to the average height of the shrub and not to the longest branch. Height and spread dimensions specified refer to the main body of the trees (measured from the crown of the roots to the tip of the top branch) and shall be not less than the minimum size designated.

C. Caliper measurements shall be taken at a point on the trunk six inches above natural ground line for trees up to four inches in caliper, and at a point 12 inches above the natural ground line for trees exceeding four inches in caliper.

D. If a range of size is given, no plant shall be less than the minimum size, and not less than 50% of the plants shall be as large as the upper half of the range specified.

E. The measurements specified are the minimum size acceptable and, where pruning is required, are the measurements after pruning.

F. All dimensions on Schedule shall be the minimum acceptable size. Plants larger in size than specified in the Plant List may be used if approved by the Landscape Architect. If the use of larger plants is approved, the ball of earth or spread of roots shall be increased in proportion to the size of the plant.

G. The minimum acceptable ball size for trees shall be 11-inch diameter per 1-inch caliper taken 6-inches above the ground for trees up to and including 4-inch caliper. Caliper shall be measured 12-inches above the ground for trees larger than 4-inch caliper. In special cases the ball size may be reduced as directed or approved by the Landscape Architect.

1.07 NOTIFICATION OF DELIVERY

A. Unless otherwise authorized by the Landscape Architect, the Contractor shall notify the Landscape Architect at least 48 hours in advance of the anticipated delivery date of any plant materials.

1.08 RIGHT OF REJECTION

A. The Landscape Architect reserves the right to inspect and reject plants at any time and at any place. Plants held on site for longer than 2 months must be approved by Landscape Architect before installation

1.09 MAINTENANCE

A. All planting shall be protected and maintained by the Contractor until time of final acceptance as defined in the guarantee. Maintenance shall include but is not limited to watering, weeding, cultivating, removal of dead material, resetting plants to proper grades or upright position, lawn mowing, fertilizing, and other necessary operations. The Owner is responsible for providing adequate maintenance during the warranty period. The Contractor shall submit, in writing, maintenance instructions for use by the Owner in caring for the plants.

1.10 PLANT GUARANTEE

A. All plants, grass, shrubs and trees shall be guaranteed to be alive and healthy two years after the date of final acceptance. The Owner is responsible for notifying Contractor of any plant, including grass, or tree that is dead or not showing satisfactory growth. After not more than a 90-day period following notification, said plant shall be replaced, or conditions contributing to unsatisfactory growth shall be corrected by Contractor. All replacements shall be of the original quality and shall be of a size equal to that attained by adjacent plants or trees of the same species. Replacement plant material shall be guaranteed to be alive and healthy at the beginning of the following growing season. Only one replacement will be required for each dead grass area. The number of replacements for other plant materials is not limited.

B. The guarantee may become void if it is determined that plant material death or unsatisfactory growth results from Owner negligence. The decision for determination of responsibility for damage shall rest solely with the Landscape Architect.

1.11 FINAL APPROVAL

A. The Landscape Architect shall have the final approval for acceptance of the landscaping.

PART 2 - PRODUCTS

2.01 GENERAL

A. Water: All water necessary for planting and maintenance shall be of satisfactory quality to sustain the growth of plants and shall not contain harmful, natural or man-made elements detrimental to plants. Water meeting the above standard shall be furnished by the Contractor and all arrangements for securing water and any expenses of transporting to the site and dispersal on the site shall be the responsibility of the Contractor.

B. Commercial Fertilizer: Provide a complete fertilizer, uniform in composition, dry and free flowing, delivered to the site in the original unopened containers, each bearing the manufacturer's statement of analysis, meeting all requirements specified in soils tests.

C. Lime: Shall be agricultural grade hydrated dolomitic lime, pelletized lime, and shall be of such fineness that 90% will pass through a No. 20 sieve and not less than 50% through a No. 50 sieve.

D. Soil Test: Revise fertilizer analysis, quantities of fertilizer and lime as dictated by soil tests made prior to planting.

E. Hardwood Mulch: Shall be aged for a minimum of three years and ground to a fine texture. Mulch shall be fresh, clean, free from sticks, cones, leaves and other debris.

F. Pine Straw Mulch: Shall be fresh, clean, free from sticks, cones, leaves and other debris. Pine straw mulch shall be used and maintained as a three-inch top dressing in all plant beds and around all trees planted by the Landscape Contractor. Single trees or shrubs shall be mulched to the outside edge of the saucer. Depth to be minimum three inches at final acceptance.

G. Topsoil: Where required shall be a natural, fertile, friable soil, possessing characteristics of representative productive soils in the vicinity. It shall be obtained from naturally well-drained areas, free from substances harmful to plant growth, and free from clay lumps, stones, stumps, roots, or similar substances two inches or more in diameter. The source and material shall be approved by the Landscape Architect before placing on site. Topsoil shall be free from noxious grass and weeds.

H. Peat Moss: Shall not be used.

I. Pre and Post emergent Herbicide: Contractor to have a licensed herbicide applicator with a minimum three years experience performing all herbicide applications to lawns, trees and shrubs. Herbicides shall be utilized employing Best Management Practices and only as necessary to control weeds in bed, tree plantings and turf areas, unless applicable codes or ordinances stipulate otherwise. Contractor is responsible to be familiar with all applicable local, state and federal codes, ordinances and regulations. No post or pre-emergent shall be applied to the soil until after all plant installation is complete and before mulching is installed.

J. Staking Material: Trees: Stakes for guying trees under shall be No. 2 Southern Pine, 2 x 2, 36-inch, pressure treated with waterborne preservative complying with AWPA standards U1-04 and T1-04, below ground contact standard, with ACQ minimum retention of 0.40 LB/cu ft.

K. Guying: ArborTie (tm) green or white staking and guying material is to be flat woven polypropylene material, ¾" wide, 900 lb. break strength. Arbortie shall be fastened to stakes in a manner which permits tree movement and supports the tree in accordance with manufacturer's instructions.

L. Seed: All seed shall be certified stock and appropriately labeled. Contractor shall deliver empty seed bags to Landscape Architect on site.

M. See Planting Plan and schedule for plants required. Quantities necessary to complete the work shown on the drawings shall be furnished. Although quantity estimates have been carefully made, the Landscape Architect assumes no liability for omissions or errors.

N. Plants that meet the requirements specified on the Plant List, but which do not possess a normal balance between height and spread will not be accepted. All plants shall be fresh dug, sound, healthy, vigorous, well branched and free of disease and insect egg and larvae and shall have adequate root systems. Trees for planting in rows shall be uniform in size and shape. All materials shall be subject to approval by the Landscape Architect. Where any requirements are omitted from the Plant List, the plants furnished shall be normal for the variety. Plants shall be pruned prior to delivery only upon the approval of the Landscape Architect.

O. Container Grown Material: All container grown materials shall be healthy, vigorous, well-rooted and established in the containers in which they are sold. They shall have tops which are of good quality and are in a healthy growing condition.

P. An established container grown plant shall be transplanted into a container and grown in that container sufficiently long for the new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

Q. The container shall be sufficiently rigid to hold the ball shape protecting the root mass during shipping.

R. Container stock shall be delivered to the site in first class condition. Plants shall have stakes in containers where required to support the plants. Plants furnished in containers shall not be handled by the stems, but only by the containers. Plants root bound in containers shall not be accepted.

2.02 QUALITY OF PLANTS

A. Plants shall in all cases conform with requirements of the following:

1. Trees and shrubs must comply with the standards found in the most recent edition of the American Standard for Nursery Stock (ANSI Z60.1), published by the American Nursery and Landscape Association (The Standard). If you need to purchase a copy of the Standard, contact ANLA Publications in Washington, DC at 202-789-5980, extension 3019.
2. Georgia State Plant Board Codes and Standards.
3. Georgia Nurseryman and Grower's Association Approved Planting Practices.
4. Bailey, Hortus III

B. Unless specifically noted otherwise, all plants shall be of selected specimen quality, exceptionally heavy, symmetrical, tightly knit, so trained or favored in their development and appearance as to be superior in form, number of branches, compactness and symmetry. All plants shall have a normal growth habit, be free of disease, show vigorous health and have a well developed root system.

C. Plants shall be free of disease, insect pests, eggs or larvae.

D. Plants shall not be pruned before delivery.

E. Trees with abrasion of the bark, sunscalds, disfiguring knots or fresh cuts of limbs over one and one-fourth inches which have not completely callused shall be rejected.

F. All plants shall be typical of their species or variety and shall have a normal habit of growth and be legibly tagged with the proper name. All plants shall have been grown under climatic conditions similar to those in the locality of the site of the project under construction or have been acclimated to such condition for at least two years.

G. The root system of each shall be well provided with fibrous roots. All parts shall be sound, healthy, vigorous, well-branched and densely foliated when in leaf.

H. Container stock shall be delivered to the site in first class condition. Plants shall have stakes in containers where required to support the plants. Plants furnished in containers shall not be handled by the stem, but only by the containers. Plants that are root bound by their containers shall not be accepted.

I. Balled and burlapped plants (BB) shall be dug with firm, natural balls of soil and of sufficient size to encompass the fibrous and feeding roots of the plants. No plants moved with a ball shall be planted if the ball is cracked or broken, except upon special approval. Plants balled and burlapped shall be handled by the stems.

J. Plants marked "BR" in the Plant List shall be dug with bare roots. The roots shall not be cut within the minimum spread specified in the Plant List. Care shall be exercised that the roots do not dry out in moving.

PART 3 - EXECUTION

3.01 GENERAL

A. Planting operations shall be conducted under favorable weather conditions preferably during the period from October 1 to March 15. The Contractor has the option and assumes full responsibility for planting in unseasonable conditions.

B. Planting of grass shall be accomplished during recommended season dependent on specified grass and planting method.

C. Protect roots or balls of plants at all times from sun and drying winds, water and freezing, as necessary until planting.

3.02 PROTECTION

A. Before commencing work, all trees and shrubs which are to be saved must be protected from damage by the placement of fencing flagged for visibility or some other suitable protective procedure approved by the Owner. No work may begin until this requirement is fulfilled.

B. In order to avoid damage to roots, bark or lower branches, no truck or other equipment shall be driven or parked within the drip line of any tree, unless the tree overspreads a paved way.

C. The Contractor shall use any and all precautionary measures when performing work around trees, walks, pavements, utilities, and any other features either existing or previously installed under this Contract.

D. The Contractor shall adjust depth of earthwork and loaming when working immediately adjacent to any of the aforementioned features in order to prevent disturbing tree roots, undermining walks and pavements, and damage in general to any existing or newly incorporated item.

E. Plants transported to the project in open vehicles shall be covered with tarpaulins or other suitable covers securely fastened to the body of the vehicle to prevent injury to the plants. Closed vehicles shall be adequately ventilated to prevent overheating of the plants. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage shall be cause for rejection. All plants shall be kept moist, fresh, and protected. Such protection shall encompass the entire period during which the plants are in transit, being handled, or are in temporary storage.

3.03 PLANTING PROCEDURE

A. Cleaning Up Before Commencing Work: The Contractor shall clean up work and surrounding areas of all rubbish or objectionable matter. All mortar, cement and toxic material shall be removed from the surface of all plant beds. They must not be stirred with the soil. Extensive clean up work will not be required under this Contract. Should the Contractor find such conditions beneath the soil which shall in any way adversely affect the plant growth, he shall immediately call it to the attention of the Landscape Architect. Failure to do so before planting shall render the Landscape Contractor liable for subsequent problems arising from unacceptable subsoil conditions. Use approved herbicide to eliminate temporary plant material as directed.

B. Moving Plants: When trees and smaller plants are moved, the root ball should always be supported. Trees and shrubs should never by handled by the trunk.

C. Stake Out: Stake tree or plant locations and secure approval of them from the Landscape Architect before digging pits, and make adjustments as directed. Locate no tree closer than two feet from pavement or structures.

D. Planting Pit Size: For ball up to two feet in diameter shall be twice the diameter of the ball. Diameter of hole for ball two feet and greater shall be two feet larger in diameter than diameter of ball. Excavate pits with vertical sides.

E. Planting Soil Mixture: For trees shall consist of 1/3 topsoil and 2/3 thoroughly pulverized existing soil mixed with fertilizer and lime if specified in soil test results.

F. Large Plastic Containers: After approval of plant location and orientation by Owner or Owner's representative, cut off bottom of containers over 5 gallons, place plant and containers in planting hole, cut the container on two sides, removing the remaining part of the container. Examine roots to insure that roots have not begun to circle the container. If roots have begun to circle the plant, Contractor may realign the roots in the hole. If root circling is too severe, plant must be rejected and returned to supplier.

G. Wire Baskets: After placing in planting hole and obtaining approval of plant location and orientation by Owner or Owner's representative, remove all twine and rope used to secure wire basket and burlap. Push the wire to the bottom of the root ball. Fill planting pit to two thirds depth with approved planting soil then slit and remove all burlap from the top of the ball at least 1/3 of the way down sides or further as possible. Backfill and cover top of ball with mulch.

H. Trees and Shrubs: Trees shall be set straight and at such level that after settlement the plant crown shall be a minimum of 2 inches above grade. Trees with a ball size of 24" or larger shall be set 4" above grade to allow for settlement. Shrubs shall stand 1 inch – 2 inches above grade mounded. Each plant shall be set in the center of the pit. Backfill mixture shall be thoroughly tamped around the ball and shall be settled by water after tamping. A water holding saucer shall be formed with extra soil. Do not handle the tree by the trunk or use the trunk to straighten or adjust the location. (See Details)

I. Fill: Fill hole with soil mixture and fertilizer as required. Pack lightly with feet. Add more soil. Do not cover top of ball with soil, only with mulch. Make sure no burlap is exposed since exposed burlap acts as a wick causing excessive loss of water.

J. Water Basin: Build basin around all plants or trees which stand alone and are not in larger mulched beds. A water holding earth dam shall be built on the outside of the hole to form a basin to hold water; it shall be 4 – 6-inches high of soil firm enough to remain in place. If necessary, bring in soil. See Detail.

K. Pruning: Each tree shall be pruned to preserve the natural character of the plant as directed by the Landscape Architect. All soft wood or sucker growth and all broken or badly damaged branches shall be removed with a clean cut.

L. Guying or Staking: Shall be done immediately after planting. Trees shall stand plumb after staking or guying in accordance with the Drawings.

3.04 FINISH GRADING

A. Prior to applying mulch, plant beds shall be stirred 3-inches deep to loosen soil mixture. Fine grade areas until all bumps and depressions are removed and until the grade conforms to requirements of the grading plan. Eliminate any water pockets and verify surfaces drain away from all buildings. The minimum surface slope of plant beds shall be four percent. Minimum surface slope in lawn areas shall be two percent.

3.05 WEED CONTROL (HERBICIDE)

A. Immediately after planting and before applying the mulch, apply pre emergent herbicide per manufacturer's instructions. Apply to all plant beds. Protect lawns, annual beds, ferns, meadow areas and any other susceptible plants. Do not apply within 50 feet of any wetland, stream, lake or other body of water. Do not apply to wet foliage.

3.06 MULCHING

A. On completion of planting, all trees, shrubs and ground cover areas shall be mulched with 3-inch layer of pine straw. All annual beds shall be covered with 2-inch layer of pine bark mini-nuggets.

3.07 TURF

A. General: Includes soil preparation, applying fertilizer, planting and maintenance as required to produce an acceptable stand of grass on areas shown on planting plan.

1. Any damage to planting soil by erosion, construction equipment, construction operations, or other damage shall be repaired prior to application of fertilizer. Finished surface shall be smooth and even.

B. Soil Preparation: After the area to be grassed has been brought to finished grade, prepare the soil by thoroughly loosening the area by plowing, discing, harrowing, or scarifying until these areas are friable, well pulverized and acceptable to the Landscape Architect. Any irregularities in the surface resulting from the above operation or from other operations by the Contractor shall be smoothed out before any subsequent operations are begun. All roots and stones larger than 1-1/2-inch in any dimension, stumps and other foreign material detrimental to final grading, proper bonding, the rise of capillary moisture, or the proper growth of the desired plantings shall be removed.

1. The completed surface shall conform to the finished grades or subgrades shown and shall have a smooth pulverized surface at the time of planting. Any irregularities shall be corrected before the lime and fertilizer are placed.
2. Spread lime and fertilizer over the prepared surface before turning. Fertilizer and lime shall be sufficient to correct irregularities in the soil based on soil tests for the specified turf. Turn the soil one last time the day before planting or placing sod.

C. Sodding

1. Sod is to be blue tag certified for species designated on Drawings.
2. Sod is to be installed from sod rolls: min. width is to be 42-inches and minimum length is to be 30 feet. Owner's Representative will reject any sod segments less than 30 feet in length.
3. Prepare planting bed as described for seeded areas except that fine graded soil shall be 1 inch below finished grade established by the grading plan.
4. Stored sod of the species required in the Schedule shall be kept moist prior to laying. Wet all areas prior to sodding.
5. Unroll the sod on the prepared soil. Lay the strips parallel with the strip ends staggered as in bricklayers' running bond pattern. Press each successively laid strip snugly up against the one next to it. Fill cracks, holes, joints with clean, loose sand, free of all grass and plant seeds. Owner's Representative to be the sole judge of acceptance.
6. Watering, fertilizing and rolling shall be done by the Contractor as described under "Maintenance of Sodded Areas" below.

D. Maintenance of Sodded Areas: The Contractor shall be responsible for maintaining sodded areas by properly watering, weeding and mowing the grass until an acceptable stand has been produced, and been accepted by the Owner and a minimum of 30 days thereafter.

1. A stand shall be considered acceptable when 95% of the total sodded area has been covered with grass and no bare areas greater than one square foot exist. All cracks, joints, dips, pits and other irregularities in the surface must have been corrected by top dressing with sand.
2. The Contractor shall be responsible for resodding all bare areas greater than one square foot with the specified mixture and for repairing and resodding wash-outs and eroded areas to the original finished grade.
3. Sodded areas shall be mowed when the grass attains a height of 2 inches and as required thereafter until the acceptance of the stand. Reel type mowers, kept well sharpened, shall be used. Turf shall not be accepted until all sod has knitted together and tacked to the soil.
4. All lawn areas shall be given a top dressing of fertilizer to provide 100 pounds available nitrogen per acre when the grass has attained a satisfactory growth and the first mowing has been performed. Nitrogen shall be derived from Ammonium Nitrate or Nitrate of Soda.
5. Contractor shall be responsible to administer a final top dressing of the turf to fix all dips, pits, cracks, etc., for up to 6 months after final acceptance.

E. Seeding

1. Area: All exterior ground within the limit of contract, except surfaces occupied by buildings, structures, paving, and except areas indicated to be undisturbed or mulched, shall be seeded or planted as shown on Drawings.
   a. Furnish topsoil.
   b. Finish grading.
   c. Prepare seed bed.
   d. Seed and maintain areas as indicated on the Drawings.
2. Seed bed preparation: Grade areas to finish grades, filling as needed or removing surplus dirt and floating areas to a smooth, uniform grade as indicated on grading plans. All lawn areas shall slope to drain. Where no grades are shown, areas shall have a smooth and continual grade between existing or fixed controls (such as walks, curbs, catch basins, elevational steps or buildings) and elevations shown on plans. Roll, scarify, rake and level as necessary to meet approval of the Landscape Architect, before grass seed is sown. Loosen soil to a depth of six inches in lawn areas by approved method in the specifications and grade to remove ridges and depressions. Remove stones or foreign matter over two inches in diameter from the top two inches of soil. Float lawn areas to approximately finish grades.
3. Seed beds should be permitted to settle or should be firmed by rolling before seeds are broadcast.
4. Seeding should not be performed in windy weather.
5. Seeding shall be done in two directions at right angles to each other.
6. Lawn areas shall be seeded by sowing evenly with an approved mechanical seeder at the rate of a minimum of three pounds per 1,000 square feet. Culti-packer or approved similar equipment may be used to cover the seed and to form the seed bed in one operation. In areas inaccessible to culti-packer, the seeded ground shall be lightly raked with flexible rakes and rolled with a water ballast roller. After rolling, seeded areas are to be lightly mulched with wheat straw.
7. If the Project completion date prohibits in-season planting, the Contractor shall prepare for out-of-season seeding or sodding so that all lawns shall be completed and ready for acceptance at time of Project completion, without additional cost to the Owner. Lawn maintenance shall be the same as for other planting.
8. Lawns shall be maintained by the Contractor for at least 30 days after sodding and 60 days after seeding, or as long as is necessary to establish a uniform stand of the specified grasses, or until substantial completion of the Project or until acceptance of lawns, whichever is later.
9. In the event that lawn operations are completed too late in the fall for adequate germination and/or growth, maintenance shall continue into the following growing season or until a uniform stand of the specified grasses has been established.
10. Water seeded areas twice the first week to a minimum depth of six inches with a fine spray and once per week thereafter as necessary to supplement natural rain to the equivalent of one inch or to a six-inch depth.
11. The surface layer of soil for seeded areas must be kept moist during the germination period. After first cutting, water as specified above.
12. Make weekly inspections to determine the moisture content of the soil and adjust the watering schedule established by the irrigation system installer to fit conditions.

13. After grass growth has started all areas or parts of areas which fail to show a uniform stand of grass for any reason whatsoever shall be reseeded in accordance with the plans and as specified herein. Such areas and parts of areas shall be reseeded repeatedly until all areas are covered with a satisfactory growth of grass at no additional cost to the Owner.

14. Watering shall be done in such a manner and as frequently as is deemed necessary by the Contractor to assure continued growth of healthy grass. All areas of the site shall be watered in such a way as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to the finished surface due to the watering equipment.

15. Water for the execution and maintenance of this work shall be provided by the Owner at no expense to the Contractor. The Contractor shall, however, furnish his own portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport the water from the available outlets and apply it to the seeded areas in an approved manner.

16. Mowing of the seeded areas shall be initiated when the grass has attained a height of one and one-half to two inches. Grass height shall be maintained between one and one-half inches at subsequent cuttings depending on the time of year. Not more than one third of the grass leaf shall be removed at any cutting and cutting shall not occur more often than ten days apart.

17. When the amount of invading grass is heavy, it shall be removed to prevent destruction of the underlying turf. If weeds or other undesirable vegetation threaten to smother the planted species, such vegetation shall be mowed or, in the case of rank growths, shall be uprooted, raked and removed from the area by methods approved by the landscape architect.

18. Protect seeded areas against trespassing while the grass is germinating. Furnish and install fences, signs, barriers or any other necessary temporary protective devices. Damage resulting from trespass, erosion, washout, settlement or other causes shall be repaired by the Contractor at his expense.

3.08 CLEANING

A. Perform cleaning during installation of the work and upon completion of the work, remove from site all excess materials, debris and equipment. Repair damage resulting from landscape operations.

B. After all work has been completed and all soil settled and final finished grading completed, clean-up and adjustments shall be made to insure proper depth of topsoil, proper drainage, proper grades adjacent to walks and curbs, proper slope of plant beds, etc. Remove any soil, mulch or plant materials from walks and paving, leaving the areas broom clean.

END OF SECTION 02900

SECTION 03100
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install the concrete formwork as required by the concrete outlines shown and indicated on the Drawings and specified in this Section, complete. The use of stay in place forms is expressly prohibited.

B. Coordination: Notify other contractors in advance of the trades of the formwork to provide the other trades with sufficient time for the installation of items included in their contracts that must be installed with the formwork.

C. Form Design: Formwork shall comply with ANSI A10.9 and OSHA Construction Standards, Part 1926, Subpart Q, Concrete, Concrete Forms, and Shoring. In addition, the form designs shall meet the requirements of ACI 347.

1.02 SUBMITTALS

A. Submit for approval copies of manufacturer's data and installation instructions for proprietary materials, including form coatings and releasing agents, manufactured form systems, ties and accessories.

B. Do not provide submittals for the structural design of forms.

1.03 QUALITY ASSURANCE

A. Allowable Tolerances:

1. Construct formwork to provide completed concrete surfaces complying with tolerances specified in ACI 347.
2. Maximum acceptable deflection is 1/8" in 5'-0" on all flat surfaces (ACI 347 Class A Finish).

B. Notify the Engineer a minimum of 48 hours before closure of forms that would hinder the subsequent inspection to enable the Engineer to inspect the work.

1.04 PRODUCT DELIVERY. STORAGE AND HANDLING

A. On delivery to jobsite, place materials in area protected from weather.

B. Store materials above ground on framework or blocking. Cover wood for forms with protective waterproof covering. Provide for adequate air circulation or ventilation.

C. Handle materials to prevent damage.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

A. Forms for Exposed Finish Concrete: (Smooth Finish)

1. Unless otherwise shown or specified, construct formwork for concrete surfaces exposed to view in the finished structure, with plywood, metal, metal-framed plywood-faced or other panel type materials acceptable to Engineer, to provide continuous, straight, smooth as-cast surfaces.

2. Furnish in largest practical sizes to minimize number of joints and to conform to joint system shown or specified. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

B. Forms for Unexposed Finish Concrete: (Rough Finish)

1. Form concrete surfaces that will be unexposed in the finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber that is dressed on at least 2 edges and 1 side.

C. Form Ties

1. Provide factory-fabricated, removable or snap off metal form ties designed to prevent form deflection, and to prevent spalling of concrete surfaces upon removal. Materials used for tying Forms will be subject to approval of the Engineer.

2. Unless otherwise shown, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1 inch from the outer concrete surface. Unless otherwise shown, provide form ties that will leave a hole no larger than 1-inch diameter in the concrete surface.

3. Ties for exterior walls and walls subject to hydrostatic pressure shall have waterstops that are integral with the tie, preferably a solid washer at mid-point of the tie.

4. Provide wood or plastic cones for ties, where concrete is exposed in the finished structure.

D. Forms Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 - EXECUTION

3.01 DESIGN OF FORMWORK

A. Formwork shall be in accordance with ACI 347 and as follows:

1. Design, erect, support, brace and maintain formwork so that it shall safely support vertical and lateral loads that might be applied, until such loads can be supported by the concrete structure. Carry vertical and lateral loads to ground by formwork system or in-place

construction that has attained adequate strength for this purpose. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.

2. Design forms and falsework to include make full allowance for all of live loads, dead loads, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency, ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.
3. Forms shall conform to shape, lines and dimensions of members indicated and shall be sufficiently rigid and tight to prevent leakage of mortar. Forms shall be properly braced or tied together so as to maintain position and shape. Construct forms so that they can be removed readily without hammering or prying against the concrete. Forms shall be carefully made and accurately placed to obtain correct shape and lines.
4. Joints shall be butted tight. Arrangements of panels shall be orderly and symmetrical, and use of small pieces shall be avoided. Forms shall be chamfered 1-inch for external corners of concrete, including tops of walls, which will be exposed to view in the finished work.
5. Provide adequate formwork in its entirety. Forms shall safely support loads they will sustain and shall maintain their dimensional and surface correctness to produce members required by the Drawings. Form ties shall be spaced close enough to avoid bulges and variations in the required cross-sectional dimensions shown on the Drawings for the members being cast.
6. Box out for chases, recesses or other openings required in the completed work.
7. Install all the items (sleeves, inserts, hangers, anchors, etc.), to be supported by the formwork as required by the work.
8. Install pipe sleeves, wall pipes and wall sleeves, as shown or specified, for all piping penetrating walls and slabs. The use of block-outs in walls is prohibited.
9. Provide a sufficient number of cleanout doors at the base of walls and columns to facilitate cleaning and the application of grout to the base of walls.
10. The use of reinforcing steel, partially embedded in concrete, as toe pins or form spacers is prohibited.

B. Forms for Exposed Concrete

1. Do not use metal cover plates for patching holes or defects in forms.
2. Provide sharp, clean corners at intersecting planes, without visible edges of offsets. Back joints with extra beams or girts to maintain true, square intersections.
3. Use extra beams walers and bracing to prevent bowing of forms between beams and to avoid bowed appearance in concrete. Do not use narrow strips of form material that will produce bow.
4. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.
5. Form molding shapes, recessed and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.
6. Chamfer exposed corners and edges.

C. Corner Treatment

1. Form exposed corners of beams, walls, bases and columns to produce smooth, solid, unbroken lines, except as otherwise shown. Except as specified below for re-entrant or internal corners, exposed corners shall be chamfered.

2. Form chamfers with ¾ by ¾ strips, unless otherwise shown, accurately formed and surfaced to produce uniformly straight lines and tight edge joints. Extend terminal edges to required limit and miter chamfer strips at changes in direction.

3. Re-entrant or internal corners and unexposed corners may be formed square.

D. Joints: See Specification Section 03250 and Drawings for treatment of joints. Locate as shown and specified.

E. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is to be placed. Re-tighten forms immediately after concrete placement as required to- eliminate mortar leaks.

3.02 FORM COATINGS

A. Coat form contact surfaces with a non-staining no petroleum form coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces, which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions.

B. Volatile organic compound emissions of form releasing agents shall not exceed 2.09 pounds per gallon or that as acceptable in the state, county, or district of their intended use, whichever is more stringent.

C. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

1. Form releasing agents must not impair subsequent treatment of concrete surfaces that depend upon bond or adhesion nor impede the wetting of surfaces to be cured with water or curing compounds.

3.03 INSTALLATION OF EMBEDDED ITEMS

A. General

1. Set and build into the formwork, anchorage devices and other embedded items, shown specified or required by other Section. Refer to paragraph 1.01 herein for the requirements of coordination. Use necessary setting drawings, diagrams, instructions and directions.

2. All embeds should be supported, plumbed and carefully taped or covered to prohibit the infiltration of concrete during the pour.

3. Coat any aluminum or reactive metal inserts, with non-reactive coating to isolate the metal surfaces.

B. Edge Forms and Screed Strips for Slabs and Sidewalks

1. Set edge forms or bulkheads and intermediate screed strips for slabs and sidewalks to obtain required elevations and contours in the finished slab surface. Provide and secure units to support screeds.

2. The screeds may not be tack welded to the rebar embeds, or structural steel.

3.04 FIELD QUALITY CONTROL

A. Before concrete placement, the Engineer shall inspect all formwork. No concrete shall be poured without Engineer approval.

B. Before concrete placement, Contractor shall check the formwork, including lines, ties, tie cone, and form coatings. Contractor shall make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

C. During concrete placement Contractor shall check formwork and related supports to ensure that forms are not displaced and that completed Work shall be within specified tolerances.

D. If Contractor finds that forms are unsatisfactory in any way, either before or during placing of concrete, placement of concrete shall be postponed or stopped until the defects have been corrected, and reviewed by the Engineer.

3.05 REMOVAL OF FORMS

A. Remove forms and falsework in a manner that will prevent damage to the concrete and not impair the safety of the structure.

B. Do not use pinch bars or similar tools to pry against concrete surfaces.

C. Do not remove forms until concrete has aged as follows:

1. Elevated slabs and beams: 7 days minimum.

2. Grade beams, columns, walls, construction and expansion joint bulkheads and other vertical surfaces: 24 hours minimum.

D. Elevated slabs and beams shall have attained at least 70 percent of the specified 28 day strength before form removal. Concrete shall also have sufficient strength to safely support its own weight and construction loads. Determine concrete strength for form removal in conformance with ACI 301.

E. Reshore elevated concrete elements immediately upon form removal. Shoring shall remain in place until the concrete has attained the specified 28 day design strength.

F. Maintain shoring of elevated concrete elements which support subsequent construction when the subsequent construction loads exceed the design live load of the elements

3.06 REUSE OF FORMS

A. Clean and repair surfaces of forms to be re-used in the Work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

1. Plywood surfaced forms must have smooth clean faces for re-use, and may not have excessive knots or tie hole plugs. They may not be used more than 3 times without an Engineer's inspection and approval.
2. Metal surfaced forms must have a smooth even surface without plate patches.

END OF SECTION 03100

SECTION 03200
CONCRETE REINFORCEMENT AND DOWELLING

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install the concrete reinforcement as shown and indicated on the Drawings and specified in this Section, complete in place.

B. Provide and set reinforcement and accessories for electrical work as indicated and specified under electrical work.

C. Provide reinforcing bar dowels to be embedded into concrete elements at top and bottom of CMU walls as indicated and specified. Furnish wall reinforcement for concrete masonry walls for installation.

1.02 SUBMITTALS

A. Shop Drawings

1. All shop drawings shall be of the same size. Reproductions of the Drawings for use as shop drawings are not permitted. Shop drawings shall include placing drawings, bending details, and bar lists with bar marks. All details and notes appearing on the Drawings, giving information for the placing of reinforcing steel, shall be shown on the shop drawings. Shop drawings will not be reviewed without such information.
2. Wall reinforcing shall be shown in elevation.
3. Show location and size of all penetrations greater than 6-inches in diameter or across the opening with the corresponding added reinforcing around the penetrations.
4. Location and arrangement of accessories shall be clearly indicated.
5. All shop drawings shall be checked by the fabricator and Contractor before being submitted to the Engineer.

B. Mill tests of reinforcing steel shall be submitted prior to use for each 15 tons or less shipped to the site. Tests shall be conducted in conformance with ASTM A615, and methods prescribed herein.

1. Cost of mill tests shall be borne by Contractor.
2. Three copies of each test report stating whether the material meets the requirements of the ASTM specifications shall be submitted to the Engineer.
3. Certified copies of the mill tests may be considered evidence of compliance provided such tests are regularly conducted by the reinforcement supplier by experienced, competent personnel using adequate testing equipment. In case of doubt as to the adequacy or accuracy of the mill tests, the Engineer may require the Contractor to furnish, at no additional cost to the Owner, test results from an independent testing laboratory acceptable to the Engineer on mill samples or delivered steel reinforcement.

1.03 QUALITY ASSURANCE

A. Minimum Concrete Cover for Reinforcement: Comply with ACI 350, except as shown on Drawings

B. Splices other than lap splices shall not be used except where permitted in writing by the Engineer.

C. Field bending of reinforcement is prohibited unless reinforcement is indicated or specified to be field bent.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver concrete reinforcement materials to the site bundled, tagged and marked. Use metal tags indicating bar size, length, and other information corresponding to markings shown on placement diagrams. Reinforcement which arrives on the jobsite which is not tagged shall be rejected by the Engineer.

B. Store concrete reinforcement material at the site to prevent damage and accumulation of dirt or excessive rust. Store on heavy wood blocking so that no part of it will come in contact with the ground.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars and Dowelling shall conform to ASTM A 615, Grade 60.

B. Steel Wire: Shall conform to ASTM A82.

C. Welded Smooth Wire Fabric: Shall conform to ASTM A185:

1. Furnish in flat sheets, not rolls.

D. Supports for Reinforcement: Bar supports coming into contact with forms shall be CRSI Class 1 plastic protected or Class 2 stainless steel protected and shall be located in accordance with CRSI MSP-1 and placed in accordance with CRSI PRB. Precast concrete block supports shall be provided for reinforcing in concrete cast against grade.

2.02 FABRICATION

A. General: Fabricate reinforcing bars to conform to required shapes and dimensions, with fabrication tolerances complying with CRSI "Manual of Standard Practice" and ACI minimums. In case of fabricating errors, do not re-bend, retemper, heat, deform or straighten reinforcement.

B. Unacceptable Materials: Reinforcement with any of the defects listed below will not be permitted in the Work:

1. Bar lengths, bends, and other dimensions exceeding specified fabrication tolerances.
2. Bends or kinks not shown on approved Shop Drawings.
3. Bars with reduced cross-section due to excessive rusting or other cause.

4. Surface contamination that would affect the bond i.e., grease, dirt, paint, rust etc.

5. Heat deformed or torched bars.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with the applicable recommendations of specified codes and standards, and CRSI "Placing Reinforcing Bars" and ACI requirements for details and methods of reinforcement placement and supports.

B. Clean reinforcement to remove loose rust and mill scale, earth, ice, and other materials, which reduce or destroy bond with concrete.

C. Position, support, and secure reinforcement and dowelling against displacement during formwork construction or concrete placement and grouting operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required. No wood blocks allowed for rebar support.

1. Place reinforcement to obtain the minimum concrete coverages as shown and as specified in ACI 350. Arrange, space, and securely tie bars and bar supports together with 16 gauge wire to hold reinforcement accurately in position during concrete placement operations. Set wire ties so that twisted ends are directed away from exposed concrete surfaces.

2. Reinforcing steel shall not be secured to forms with wire, nails or other ferrous metal. Metal supports subject to corrosion shall not touch formed or exposed concrete surfaces.

D. Install welded wire fabric in as long lengths as practical. Lap adjoining pieces at least one full mesh and lace splices with 16 gauge wire and tie.

E. Provide sufficient numbers of supports of strength required to carry reinforcement without sagging. Do not place reinforcing bars more than 2 inches beyond the last leg of any continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

F. Splices: Provide standard reinforcement splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown for minimum lap of spliced bars.

G. Existing concrete, which is shown to remain but is removed in error or must be removed to install new Work, and then to be reinstalled is to be reinforced to the extent as required and approved by the Engineer. This work will be performed with no additional compensation to the Contractor.

H. Do not straighten or rebend reinforcing.

I. Reinforcement Around Openings: Place an equivalent area of steel around the pipe or openings and extend on each side sufficiently to develop bond in each bar. See the Details on the Drawings for bar extension length each side of openings. Where welded wire fabric is used, provide extra reinforcing using fabric or deformed bars.

J. Welded Reinforcement: Welding is not permitted.

3.02 INSPECTION OF REINFORCEMENT

A. After the rebar, appliance, anchors and embedments have been installed and checked, the Contractor shall review all aspects of the pending concrete pour and initial those items on its pour card. Contractor shall notify the Engineer no less than 24 hours prior to the pour, so that the Engineer may check the area to be poured. No concrete shall be placed until this is complete.

B. Concrete shall not be placed until the reinforcing steel is inspected and permission for placing concrete is granted by the Engineer. All concrete placed in violation of this provision will be rejected. Rejected concrete shall be removed and replaced at no cost to the City.

END OF SECTION 03200

SECTION 03250
CONCRETE ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by Section includes, but is not necessarily limited to, furnishing and installing all concrete accessories as indicated on the Drawings, herein specified, and as necessary for the progress and complete performance of this work.

1.02 SUBMITTALS

A. The waterstop manufacturer shall submit documented test results demonstrating that the waterstop will not permit water leakage when subjected to pressure and joint movement.

1.03 QUALITY ASSURANCE

A. The waterstop manufacturer shall demonstrate five years (minimum) continuous, successful experience in production of waterstops.

1.04 STORAGE AND PROTECTION

A. Store waterstops under tarps to protect from oil, dirt, water, and sunlight.

1.05 QUALITY CONTROL

A. Contractor shall establish and maintain records sufficient to furnish evidence of quality of materials, equipment, storage, and workmanship.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Waterstops for construction joints shall be Wirestop Waterstop Type No. FR-6380 manufactured by Paul Murphey Plastics Company, Rossville, Michigan; Vinylex Waterstop Type R6-38T manufactured by Vinylex Corporation, Knoxville, Tennessee; or Greenstreak Waterstop Stop 679 manufactured by Greenstreak, St. Louis, Missouri.

B. Expanding waterstops for construction joints shall be Hydrotite Waterstop Profile CJ-0725 manufactured by Greenstreak, St. Louis, Missouri or equal.

2.02 MATERIALS AND CONSTRUCTION

A. Waterstops

1. Waterstops shall be extruded from an elastomeric plastic compound of which the basic resin shall be prime virgin polyvinyl chloride meeting U.S. Army Corps of Engineers Specification CRD-C572-74. The PVC compound shall not contain any scrapped or reclaimed material or pigment whatsoever.

2. Provide factory installed hog rings, grommets, or embedded wire loop to facilitate tying off waterstop at 12-inches on center along the length of the waterstop.

3. Provide factory made PVC waterstop fabrications for all changes of direction, intersections and transitions, leaving only straight butt joint splices for the field.

4. Expanding waterstops shall be coextruded hydrophilic rubber consisting of a combination of chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.

5. Expanding waterstops shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.

6. Minimum profile dimensions of expanding waterstop shall be 1/4 x 1-inch.

B. Dovetail Slots

1. No. 22 gauge, galvanized steel, 1-inch wide back.

2. Crimped anchors shall be furnished by other trades whose work abuts concrete.

C. Inserts for General Trades

1. Malleable iron, strength as required.

2. Include bolts, nuts, and washers.

2.03 OTHER MATERIALS

A. All other materials not specifically described, but required for a complete and proper installation of concrete accessories, shall be as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install concrete accessories as indicated on the Drawings, specified in various other Sections and as necessary for the proper and complete performance of this work.

B. Waterstops

1. Waterstops shall be installed in all construction joints in walls and slabs which are to hold water and also where shown on the Drawings. The waterstop shall extend the entire length of the joint and all splices shall be installed and tested in accordance with the manufacturer's recommendations. Place waterstop to form a continuous watertight diaphragm in joints.

2. Waterstops for all joints shall be continuous around all corners and intersections. For PVC waterstops, provide factory formed corners and intersections where angle intersections occur, and only straight splices shall be made in the field. Splices shall be made in accordance with the manufacturer's recommendations and shall be subject to the approval of the Engineer. Maintain 2-in. [50 mm] minimum clearance between waterstop and reinforcement and embedded items.

3. No holes will be permitted in waterstops.

4. Waterstops shall be securely fastened to formwork or reinforcing steel every 12-inches or less on both edges as required to concrete placement.
5. Expanding waterstops shall be spliced using cyanoacrylate adhesive (super glue) and a band-aid seal of hydrophilic polyurethane sealant.
6. Cut coil ends of expanding waterstops square (or at proper angle for mitered corners) with shears or sharp blade to fit splices together without overlaps.
7. Joinery between PVC and expanding waterstops shall be sealed using hydrophilic polyurethane sealant.
8. Provide concrete surface preparation that is consistent with the manufacturer's recommendations for expanding waterstops. Coordinate this preparation with other joint preparation shown on the drawings.
9. Install the expanding waterstop in accordance with the manufacturer's recommendations.

END OF SECTION 03250

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE

A. Furnish and install the cast-in-place concrete as shown and indicated on the Drawings and as specified in this Section, complete.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.
2. Notify other trades in advance of the placing of concrete to provide the other trades with sufficient time for furnishing of items included in their work that must be installed in the concrete.
3. Required City formal pour card with all required signatures.

C. The following classes of concrete are required. Refer to the Drawings for their locations.

1. Class A
2. Class D
3. Class G

1.02 SUBMITTALS

A. Submit for approval the following:

1. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.
2. Copies of manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.

B. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. Production of concrete to comply with specified requirements is the responsibility of the Contractor. Submit the testing lab's average strength curve from the design mix proportions of the approved materials.

C. Submit certification of conformance to referenced standards to the Engineer and a copy of the batch plant's most recent scale calibration.

D. Delivery Tickets: Furnish to Engineer copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C 94, Section 14.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the latest edition following, except as otherwise shown or specified:

1. ACI 301, Specification for Structural Concrete for Buildings, (includes ASTM Standards referred to herein).
2. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
3. ACI 305, Recommended Practice for Hot Weather Concreting.
4. ACI 306, Recommended Practice for Cold Weather Concreting.
5. ACI 308, Standard Practice for Curing Concrete.
6. ACI 309, Recommended Practice for Consolidation of Concrete.
7. ACI 318, Building Code Requirements for Reinforced Concrete.
8. ACI 347, Recommended Practice for Concrete Formwork.
9. ACI 350, Code Requirements for Environmental Engineering Concrete Structures
10. ASTM C31, Standard Method of Making and Curing Concrete Test Specimens in the Field.
11. ASTM C33, Standard Specification for Concrete Aggregates.
12. ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
13. ASTM C40, Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
14. ASTM C42, Standard Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
15. ASTM C94, Standard Specification for Ready-Mixed Concrete.
16. ASTM C138, Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
17. ASTM C143, Standard Test Method for Slump of Portland Cement Concrete.
18. ASTM C150, Standard for Portland Cement.
19. ASTM C157, Standard Test Method for Length Change of Hardened Cement Mortar and Concrete
20. ASTM C171, (1986) Standard Specification for Sheet Materials for Curing Compounds.
21. ASTM C172, Standard Method of Sampling Freshly Mixed Concrete.
22. ASTM C173, Standard Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
23. ASTM C192, Standard Method of Making and Curing Concrete Test Specimens in the Laboratory.
24. ASTM C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
25. ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete.
26. ASTM C494, Standard Specification for Chemical Admixtures for Concrete.
27. ASTM C827, Standard Test Method for Early Volume Change of Cementitious Mixtures.
28. Federal Specification CCC-C-467C: Cloth, Burlap Jute or Kenaf.

B. Concrete Testing Service

1. By Contractor's Testing Laboratory:
   a. Contractor shall employ, at its own expense, a testing laboratory, approved by the Engineer and experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
      i) Testing agency shall meet the requirements of ASTM E 329.
      ii) Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information, which may be requested by the Engineer.
      iii) Submit certification that the testing laboratory meets the requirements of ASTM E329.
   b. Materials and installed Work may require testing and retesting, as directed by the Engineer, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be done at the City's expense, including the retesting of rejected materials and installed Work, shall be done at the Contractor's expense.
2. By Independent Testing Laboratory: Testing for concrete field quality control as specified under Paragraph 3.14 of this Specification, shall be performed by an independent testing laboratory approved by the Engineer. The cost of all concrete testing for field quality control shall be paid for by the Contractor and shall be included in the Contractor's base bid. The Contractor shall be responsible for notifying the independent testing laboratory to schedule the testing as specified.

C. Test for Concrete Materials: Submit written reports to the Engineer, for each material selected and tested, prior to the start of Work. Provide the Project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, material manufacturer and brand name for manufactured materials, values specified in the referenced Specification for each materials, and test results. Indicate acceptability of materials for intended use.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to ensure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected.

PART 2 - PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement

1. Portland cement, ASTM C 150, Type II.
2. Do not use cement which has deteriorated because of improper storage, handling or for any other reason.

B. Aggregates: ASTM C 33 and as herein specified.

1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces. Slag materials are not allowed.
2. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
   a. Dune sand, bank run sand and manufactured sand are not acceptable.
3. Coarse Aggregate: Clean granitic, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.

C. Water: Clean, free from injurious amounts of oils, acids, alkalis, potable, organic materials or other substances that may be deleterious to concrete or steel.

2.02 CONCRETE ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers, and use in compliance with the manufacturer's printed instruction. Do not use admixtures, which have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by the Engineer.

B. Water-Reducing Admixture: ASTM C 494, Type A.

C. Air entraining admixture shall conform to ASTM C 260.

D. Fly ash shall conform to ASTM C 618, Type F.

E. High range water reducer (HRWR) shall conform to ASTM C 494, Type G.

F. Calcium Chloride: Do not use calcium chloride in concrete.

G. Silica fume shall conform to ASTM C 1240.

2.03 PROPORTIONING AND DESIGN OF MIXES

A. The following classes of concrete are required.

Class of Concrete	Compressive Strength @ 28 Days	Slump Range Before HRWR	Slump Range After HRWR	Maximum W/C Ratio	Coarse Aggregate Size
A	4,000	1" – 2"	6" – 9"	0.45	57
D	4,000	1" – 2"	6" – 9"	0.42	67
G	3,000	1" – 4"	N/A	0.55	57

1. Fly ash is required in Classes A, and D concretes. The fly ash shall not exceed more than 20% of combined weight of fly ash and cement. The fly ash shall not be less than 15% of the combined weight of fly ash and cement. The combined weight of cement and fly ash shall be used as the weight of cement in the determining of the water-cement (w/c) ratio.
2. Fly ash and Silica Fume are required in Class C concrete. The combined weight of the cement, fly ash and silica fume shall contain no less than 15 percent fly ash and no less than

10 percent silica fume. The combined weight of cement, fly ash and silica fume shall be used as the weight of cement in determining the water cement (w/c ratio).

3. Slump tests shall be made prior to adding the HRWR. The HRWR shall be added to the concrete at the batch plant. The slump range required after the addition of the HRWR is indicated in the table above. HRWR shall be capable of maintaining the required slump in excess of 60 minutes of continuous mixing at 4 to 6 rpm in a truck mixer and workability up to 90 minutes. Upon 72 hours notice, the HRWR manufacturer shall supply jobsite technical service to the Contractor. The manufacturer shall be consulted for mix proportions and dosage rates. The initial set shall not be in excess of six hours at temperatures above 50 degrees F. HRWR shall be used with due consideration given to the air temperature at the time of batching and casting.
4. If field experience method is used to select concrete mixes, the proposed mix designs shall be accompanied by complete standard deviation analysis and at least 20 consecutive strength test that represent the proposed mix.
5. The proposed mix design and supporting data shall be submitted, in triplicate, to the Engineer at least 30 days prior to the expected start of concreting operations.
6. Compression test specimens made to verify the mixes shall be made in accordance with ASTM C 192. All compression test specimens shall be tested in accordance with ASTM C 39.
7. Adjustment to Concrete Mixes During Construction: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the Owner and as accepted by Engineer. Laboratory test data for revised mix designs and strength results must be submitted to the Engineer for acceptance before using the revised mixes.
8. Mix design shall be proportioned in accordance with ACI 211.1 making maximum use of the coarse aggregate. The proportioning shall be based on the requirements of a well-graded high density plastic workable mix within the slump range and strengths required. The mix shall be based on conventional conveying and shall not be altered for use in pumping. Pumping equipment, if used, shall be of sufficient size and design to pump the mix designed for conventional conveyance.
9. Submit samples, in adequate quantities for each mix design and verification, of all concrete materials to be used on the Project to the Contractor's testing laboratory. Do not use any concrete in this work without acceptance and verification of design mix by the Contractor's testing laboratory and the approval of the Engineer.
10. If Laboratory trial batches are used to select concrete mixes, the Contractor's testing laboratory shall make strength tests from trial batches in the laboratory using materials and mix designs proposed for use by the Contractor. The Contractor's testing laboratory shall prepare trial batches in accordance with ACI 211.1.
11. Class D concrete shall have an air content of 6% ± 1½%.
12. Class A concrete shall have 5 + 1% air content.
13. Class B concrete shall have 5 + 1% air content.

2.04 CHEMICAL HARDENER

A. Unless otherwise specified, all interior concrete floors of electrical and valve rooms shall be treated with a liquid hardener composed of magnesium and zinc fluorosilicates combined with an

anionic surfactant for improved wetting penetration. Liquid hardener shall be colorless, nontoxic, nonflammable, and compatible with and providing good adhesion for subsequent toppings and/or coatings. Liquid hardener shall be suitable for use on new or old concrete floors. Chemical hardener shall be FLUOHARD or Equal.

2.05 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute of kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.

1. Waterproof paper.
2. 4 mil polyethylene.

C. Curing and Sealing Compound: ASTM C-309.

PART 3 - EXECUTION

3.01 CONCRETE MIXING

A. General

1. Mixing plants shall comply with ASTM C 94 and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet construction schedule. All plant facilities are subject to inspection by the Independent Testing Laboratory and acceptance of the Engineer.
2. Mixing:
   a. Mix concrete with an approved rotating type batch machine.
   b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.
   c. Replace mixer blades when they have lost 10 percent of their original height.
   d. Plant equipment and facilities: Conform to National Ready Mix Concrete Association "Plant and Delivery Equipment Specification".
   e. Mix concrete in revolving type truck mixers, which are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
   f. Do not exceed the proper capacity of the mixer.
   g. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
   h. Do not allow the drum to sit while in transit.
   i. Mix at proper speed until concrete is discharged.
   j. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.
   k. The Contractor shall ensure that the silica fume is uniformly dispersed throughout the concrete in accordance with mixing procedures recommended by the silica fume supplier.

3.02 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes after water has been added to the dry ingredients, except as noted in Section 02425.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not retemper partially set concrete, and do not add any water at the jobsite.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

3.03 CONCRETE PLACEMENT

A. Inspection of Work Before Placing Concrete

1. Inspect the area to receive concrete for any deficiencies, which would prevent proper placing of concrete. Do not proceed with placing concrete until such deficiencies are corrected.
2. Do not place in the concrete any item that is not required to be in the concrete by the Drawings and Specifications. Insert all the items shown on the Drawings or specified properly positioned and secured. Openings other than those, which are facilitated by sleeves shall be properly formed and positioned only after approval of the Engineer.
3. Remove hardened, or partially hardened, concrete on forms or reinforcement before placing concrete.
4. Do not place concrete on earth until the fill or excavation has been prepared as set forth under applicable sections of the Specifications for that work.

B. Place concrete continuously so that no concrete will be placed on concrete, which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure, which will cause segregation.

1. Screed concrete, which is to receive other construction to the proper level to avoid excessive skimming or grouting.
2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and position and secure.
4. Unless otherwise approved, place concrete only when Engineer is present.

C. Concrete Conveying

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods, which will prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.

3. Do not use chutes for distributing concrete unless approved in writing by the Engineer.

4. Pumping of concrete is permitted, however, do not use aluminum piping to convey the concrete.

D. Placing Concrete into Forms

1. Deposit concrete in forms in horizontal layers not deeper than 18 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete, which is being integrated with fresh concrete is still plastic with adequate vibration.

2. Do not permit concrete to free fall within the form from a distance exceeding 4 feet. Use "elephant trunks" and tremies to prevent free fall and excessive splashing on forms and reinforcement.

3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by the Engineer.

5. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6 inches into the preceding layer. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.

6. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.

E. Placing Concrete Slabs and Sidewalks

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of expansion joints, until the placing of a panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.

3. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations. Coordinate applying contraction joint with finishing operations.

F. Cold Weather Placing

1. Protect all concrete Work from physical damage or reduced strength, which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.

2. When the air temperature has fallen to or may be expected to fall below 40 F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50°F and 70°F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to ensure that the ambient temperature does not fall below 30°F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.

3. When air temperature has fallen to or is expected to fall below 40 F uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55°F and not more than 90°F at point of placement.

4. Do not use frozen materials containing ice or snow. Ascertain that forms, reinforcing- steel, and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.

5. Do not use salt and other materials containing anti freeze agents or chemical accelerators, or set-control admixtures, unless approved by the Engineer, in mix designs.

G. Hot Weather Placing

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F when the temperature is rising and below 85°F when the temperature is falling. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated by the Engineer in the total amount of mixing water.

3. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

4. Wet forms thoroughly before placing concrete.

5. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.

6. Do not use set-control admixtures unless approved by the Engineer in mix designs.

7. Obtain Engineer's approval of other methods and materials proposed for use.

3.04 CONSTRUCTION JOINTS

A. Formed Construction Joints in Containment Structures and Where Otherwise Shown: Prior to placing concrete next to the joint, the joint surface shall be thoroughly cleaned and dampened with water. Remove all free water so that the surface of the joint shows signs of drying before placing the adjacent concrete.

B. Construction Joints in Beams, Girders and Slabs: These joints shall be located at points of minimum shear and their locations shall be approved by the Engineer before they are bulkheaded. These joints shall be roughened and thoroughly cleaned of all foreign matter and laitance and dampened with water. Remove all free water and slush with a coat of neat cements grout before placing the adjacent concrete. Place the adjacent concrete before the neat cements grout takes its initial set.

3.05 WATERSTOPS

A. Waterstops shall be provide where specified and as indicated and noted on the Drawings and shall be made continuous throughout their length.

3.06 FINISH ON FORMED SURFACES

A. Smooth Form Finish is required for all concrete surfaces exposed to view in the completed work and inside surfaces of all liquid containment structure walls whether exposed to view or not in the completed work. Accomplish the required patching and the following touch-up:

1. Remove all burrs.
2. Remove all form marks.
3. Smooth out lines of indentations.
4. Remove form ties and fill in indentations.

B. Rough Form Finish shall be produced by filling all tie holes and honeycomb and in other respects leaving the surface as formed. All concrete surfaces which will be covered by earth and whichwill not be visible in the completed structure (except as noted above for liquid containment structure walls which shall have a Smooth Form Finish), may receive a Rough Form Finish.

3.07 STEEL TROWELED FINISH – FLOOR SLABS

A. Steel troweled finish shall be applied to the surface of all building and liquid containment structure floor slabs and interior equipment pads.

B. Concrete shall be placed, consolidated, struck-off and leveled to the proper elevation. After the surface has stiffened sufficiently to permit the operation and the water sheen has disappeared, the surface shall be wood floated, by hand or power floated, at least twice, to a uniform sandy texture. Floors shall be leveled such that depressions between high spots do not exceed ¼-inch under a 10 foot straightedge except where drains occur, in which case the floors shall be pitched to the drains as indicated on the Drawings.

C. After the concrete has received a wood float finish, it shall be troweled at least twice to a smooth dense finish. The drying of the surface moisture between floating or troweled shall not be hastened by the dusting on of dry sand or cement. The first troweling shall be done by a power trowel and shall produce a smooth surface relatively free of defects. Additional troweling shall be done by hand after the surface has hardened sufficiently. The final troweling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand troweling operations. The finished surface shall be free of any trowel marks or other imperfections; shall be uniform in texture and appearance, and shall be

in true plane within the tolerance specified. Any deviation from this condition, which remains

after the troweling is complete, shall be corrected by grinding.

3.08 WOOD FLOAT FINISH

A. A wood float finish shall be applied to all base and top slabs in the diversion structures.

3.09 BROOM FINISH

A. Broom finish shall be applied to:

1. All exterior sidewalks, walkways and platforms.
2. All steps and landings, both interior or exterior.

B. The surface shall be given a floated finish as specified above, then finished with a flexible bristle broom or burlap belt drawn across the surface. Surface must be hardened sufficiently to retain the scoring or ridges. Scores or ridges shall be transverse to traffic or at right angles to the slope of the slab.

3.10 PROTECTION

A. Protect freshly placed concrete from damage or injury due to water, falling objects, persons or anything that may mar or injure finish surface on concrete. Only light use of slabs will be permitted for the first 14 days after placing of the concrete.

3.11 CURING

A. Curing shall conform to ACI 308 except as modified herein.

B. All Slabs on Grade: After placement and finishing, concrete shall be maintained in a moist condition for at least seven successive days during which the temperature of the concrete is 50 degrees F or above. For temperatures of 50 degrees F and below, curing period shall be 14 successive days. Concrete shall be kept moist by any one, or combination, of the following methods:

1. Ponding or Immersion: Continually immerse the concrete in water throughout the curing period. Water shall not be more than 20 degrees F less than the temperature of the concrete.
2. Fog Spraying or Sprinkling: Provide uniform and continuous application of water throughout the curing period.
3. Pervious Sheeting: Completely cover surface and edges of the concrete with two thicknesses of wet sheeting. Overlap sheeting 6-inches over adjacent sheeting. Sheeting shall be at least as long as the width of the surface to be cured. During application, do not drag the sheeting over the finished concrete nor over sheeting already placed. Wet sheeting thoroughly and keep continuously wet throughout the curing period.
4. Impervious Sheeting: Wet the entire exposed surface of the concrete thoroughly with a fine spray of water and cover with impervious sheeting throughout the curing period. Lay sheeting directly on the concrete surface and overlap edges 12-inches minimum. Provide sheeting lot less than 18-inches wider than the concrete surface to be cured. Secure edges and transverse laps to form closed joints. Repair torn or damaged sheeting or provide new sheeting. Inspect surface of concrete daily for wetness. The surface shall be kept

continuously wet during the curing period.

C. All Other Concrete

1. After placement, concrete shall be maintained in a moist condition for the same periods as specified above for slabs on grade. For concrete in formed surfaces, keep forms wet with water during the curing period. If forms are removed before the end of the curing period, continue the moist curing in accordance with Paragraph B of this Article of these Specifications.

3.12 PATCHING

A. As determined by the Engineer, any concrete, which is out of alignment or level has a defective surface or has defects, which reduce its structural adequacy, shall be considered as not conforming with the Drawings and Specifications and shall be rejected.

B. Do not take any remedial action on concrete with any defect without the permission of the Engineer.

C. Unless the Engineer grants permission to patch the rejected concrete, remove the rejected concrete and replace it with concrete that conforms to the Drawings and Specifications. The location of cut lines and the extent of removal will be determined by the Engineer.

D. If the Engineer grants permission to patch the rejected concrete, it shall be done in accordance with the following:

1. Permission to patch rejected concrete will not be a waiver of the Engineer's right to require complete removal of the rejected concrete if the patching does not, in the Engineer's judgment, restore the concrete to the requirements of the Specifications and Drawings.
2. Patching shall be accomplished after the curing is completed.
3. Defective areas shall be chipped away to a depth of not less than 1-inch, in all cases to sound concrete, with edges perpendicular to the surface. Feather edges will not be permitted. Remove all loose material and thoroughly clean the chipped surfaces with a high pressure air hose delivering air at 100 psi. The area to be patched and an area at least 6-inches wide surrounding it shall be dampened. A bonding grout shall be prepared using a mix of approximately one part cement to one part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surfaces as noted in paragraph 5.
4. The patching mixture shall be made of the same materials and of approximately the same portions as used for the original concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than one part cement to two and one-half parts sand by damp, loose volume. While Portland cement shall be substituted for a part of the gray Portland cement to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

5. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for seven days. Finishing tools that produce a finish matching the surrounding shall be used.

E. Tie holes left by withdrawal of rods or the holes lefty by removal of ends of wall ties shall be filled solid with mortar after first being wetted. For holes passing through the wall, a plunger-type grout gun shall be used to force the mortar through the wall starting at the back face. A piece of burlap or canvas shall be held over the hole on the outside and when the hole is filled, the excess mortar shall be struck off with the cloth flush with the surface. Holes not passing through the walls shall be filled with a small tool that will permit packing the hole solid with mortar. Any excess mortar at the surface of the wall shall be struck off flush with a cloth. Mortar shall consist of one part cement, two and one-half parts sand and no more water than necessary for handling and packing.

3.13 QUALITY CONTROL TESTING

A. The Independent testing laboratory shall have access to all places where concrete materials and concretes are manufactured, stored, proportioned, mixed, placed and tested. Duties shall include, but not necessarily be limited to the following:

1. Make, store, transport, cure and test compression specimens made during the placing of concrete. Compression test specimens shall be tested in accordance with ASTM C 39. Test reports shall show all pertinent data, such as class of concrete, exact location of pour, air temperature, date of pour, time of pour, truck number for ready-mixed concrete, date on which specimen was broken, age of specimen, compressive strength of specimen, concrete slump test results and air content of concrete from which the specimen was made. One copy each of all tests shall be sent to the Contractor and two copies each to the Engineer.
2. Each strength test requires four standard test cylinders.
3. Samples for strength tests of each class of concrete placed each day shall be taken not less than once a day, nor less than once for each 50 cubic yards of concrete, nor less than once for each 5,000 square feet of surface area for slabs or walls.
4. Each class of concrete shall be tested with at least five strength tests.
5. Each set of four cylinders, two shall be tested at 28 days and shall comprise a strength test under the definition of these Specifications. One cylinder shall be broken at seven days and will be used as an aid in determining the early strength of the concrete and the 28 day strength, and one cylinder retained in reserve for later testing if required.
6. Test for unit weight of concrete when the first load of each class of concrete is delivered and thereafter at the discretion of the testing laboratory.

B. Periodically inspect the batching plant and file a report with the Engineer stating whether the supplier's equipment and methods meet the requirements of these Specifications.

C. Temperature and Placing Record: Temperature record shall be made each day during the concreting operations. Records shall also include location, quantity and starting and finishing time of placement for all concrete work. Copy distribution shall be as specified above for test reports.

D. All work and reports shall comply with Applicable Industry Standards.

3.14 EVALUATION OF COMPRESSION TESTS

A. Evaluation of compression test results shall be as follows: For each class of concrete, compression-strength tests for laboratory-cured cylinders shall be considered satisfactory if the averages of the results of all sets of three consecutive compression-strength tests equal or exceed the 28 day design compression-strength specified; and, no individual cylinder strength test falls below the required compression strength by more than 500 psi. Strength tests of specimens cured under field conditions may be required by the Engineer to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded by the field testing laboratory at the same time and from the same samples as the laboratory-cured specimens.

B. Faulty Concrete: Failure to comply with any of the specified conditions shall constitute faulty concrete. Unless otherwise directed by the Engineer, faulty concrete shall be removed and replaced with concrete as specified, at no expense to the Owner.

C. Additional Test: If permitted by the Engineer, additional tests shall be subject to the approval of the Engineer at no expense to the Owner. Load tests, if permitted by the Engineer, shall be conducted in accordance with the loading criteria as required by the design of the structure, as determined by the Engineer.

D. Neither the results of laboratory verification tests nor any provision in the Contract Documents shall relieve the Contractor of the obligation to furnish concrete of the class and strength specified.

3.15 TESTING FOR WATERTIGHTNESS OF CONCRETE STRUCTURES

A. Leakage testing shall be carried out in accordance with ACI 350.1 - Tightness Testing of Environmental Engineering Concrete Structures. The test criterion shall be HST-NML (no measurable loss) as defined by ACI".

B. All concrete structures designed to contain or convey fluid shall be tested for watertightness by the Contractor prior to earth backfilling by filling with water to levels approximately what will be attained during operation and measuring the drop in level due to leakage, if any. These tests shall be made under the direction of the Engineer, and if necessary the tests shall be repeated until watertightness is ensured. Perform tests prior to backfilling below grade structures and prior to installations of any coating.

C. Rate of filling shall be limited to minimize shock-effect to new concrete construction. Water shall be held under each condition long enough to satisfy the Engineer that the structures are watertight. Structures shall be free of internal or external water leakage.

D. Leakage shall be located and stopped and the structure again tested until this requirement is met. If the structure does not meet the test, the Contractor shall repair or replace at his own expense, such part of the work as may be necessary to secure the desired results, as approved by the Engineer.

E. Regardless of the rate of leakage there shall be no visible leakage from any concrete structure.

END OF SECTION 03300

SECTION 03345
CONCRETE FLOOR TREATMENT

PART 1 - GENERAL

1.01 SCOPE

A. Provide surface treatment for dustproofing, hardening, and sealing exposed concrete floors in electrical and valve rooms.

1.02 RELATED WORK

A. Section 03300: Cast-in-Place Concrete

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:

1. D4263: Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions. In addition, the following specific information shall be provided:

1. Submit manufacturer's product data.
2. Submit manufacturer's surface preparation and application instructions.
3. Submit manufacturer's color charts.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Sections 01610 and 01611.

PART 2 - PRODUCTS

2.01 DUSTPROOF/SEALER (DPS)

A. Manufacturers:

1. Armorseal Rexthane 1 manufactured by Sherwin Williams.
2. Duraguard 300HS manufactured by ChemMasters.
3. Eucothane manufactured by the Euclid Chemical Company.
4. Or equal.

B. Provide a high solids, single component, moisture cure urethane with VOC compliance.

C. Provide surface primer in accordance with manufacturer's printed instructions.

D. Colors as indicated in Finish Schedule.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. General:

1. Prepare concrete surfaces in accordance with manufacturer's printed instructions. Concrete shall be cured for a minimum of 28 days prior to application of floor treatment.
2. Acid etching will not be allowed.
3. Concrete surfaces shall be free of dirt, oil, wax, sealers, grease, rust stains, curing and parting compounds and other foreign matter.

3.02 APPLICATION

A. Dustproof/Sealer (DPS):

1. Perform testing for vapor drive on concrete floors in accordance with ASTM D4263 prior to application. Do not apply dustproof/sealer until test results have been approved by Engineer.
2. Apply primer in accordance with manufacturer's printed instructions.
3. Give particular attention to priming of concrete substrate and time laps between coats when more than one conditioning coat is required.
4. Mix colored polyurethane dustproof/sealer surface treatment and apply to sound, fully cured, dry and thoroughly clean concrete slabs in strict accordance with manufacturer's printed instructions.
   a. Total dry film thickness for both primer and topcoat shall be 4 mils.

END OF SECTION 03345

SECTION 03361
SHOTCRETE

PART 1 - GENERAL

1.01 SCOPE

A. The work specified in this Section includes furnishing all materials, equipment, testing, production and application of shotcrete to the specified thickness at the locations shown on the Drawings.

1.02 DEFINITIONS

A. Plain shotcrete: Portland cement concrete mixture applied from a spray nozzle at high velocity by means of compressed air and containing, if necessary, admixtures to provide quick set, high early strength, and satisfactory adhesion to the rock.

B. Rebound: All material having passed through the nozzle which does not adhere to the surface on which shotcrete is being applied.

C. Dry Mix Process: Shotcrete in which a premixed blend of cement and aggregate is propelled through a hose by compressed air to the nozzle. Water is added to the cement and aggregate mixture at the nozzle and the intimately mixed ingredients are projected onto the surface. Accelerator may be added to the shotcrete mixture at the nozzle in such a way that the quantity can be properly regulated.

D. Steel Fiber: Discrete, cold-drawn, steel wire fibers which can be uniformly distributed in shotcrete to improve the toughness.

E. Synthetic Fiber: Macro-synthetic polypropylene fibers with an equivalent diameter between 0.025 inches and 0.035 inches which can be uniformly distributed in shotcrete to improve the toughness.

F. Fiber reinforced shotcrete: Similar to "plain shotcrete" except that, in addition to the plain shotcrete mix, steel fibers or macro-synthetic polypropylene fibers are incorporated into the mix.

G. Wet mix process: Shotcrete in which all the ingredients except the accelerator are mixed before introduction in the delivery hose. Accelerator is added to the shotcrete mixture at the nozzle in such a way that the quantity can be properly regulated.

1.03 QUALIFICATIONS

A. Foremen and nozzlemen, before employment on the work, shall satisfy the Engineer that each has done satisfactory work in similar capacities elsewhere for a sufficient period of time to be fully qualified to properly perform the work in accordance with the requirements indicated. Foremen shall have at least two years experience as a nozzleman, and at least two years experience as a foreman on similar work. Nozzleman shall be certified by the American Concrete Institute as outlined in ACI Certification CP 60(09) for both vertical and overhead applications for the method of shotcreting (wet mix or dry mix) that will be used on the project.

B. Each shotcreting crew will be required to fabricate two acceptable test panels for each mix and in each shooting position which the crew will encounter in the Work, prior to application of shotcrete in the Work, using the exact type of equipment intended to be used by the crew. Crews lacking acceptable proficiency, as determined by the Engineer, shall not be permitted to work on the project. The procedure for completing the test panels are in Article 1.04 C herein. Refer to Article 3.01 for requirements.

C. Should the results of control testing indicate that deficient shotcrete is being produced by a crew, the crew may be required to be requalified for the mix and shooting position in question at no additional cost to the Owner.

1.04 QUALITY ASSURANCE

A. The Contractor shall be responsible for the design of all shotcrete mixes and for the quality of the shotcrete placed in the work.

B. Pre-construction test panels and construction test panels or test cores from the in-place shotcrete are required. Shotcreting and coring of test panels shall be performed by qualified personnel in the presence of the Engineer. The Contractor shall provide the equipment, materials, and personnel as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring.

C. Pre-construction Trial – A pre-construction trial shall be used to pre-qualify the nozzlemen and mix designs for the Project. Test panels shall be constructed by each crew using the equipment, materials, mix proportions, and procedures proposed for the applications. All test panels shall be constructed at an approved location on the Project site. Those mixes to be applied using a shotcrete boom shall have test panels made using the remote boom. Each crew shall construct two test panels for each mix type and for each shooting position (i.e. vertical and overhead).

1. The test panels shall be produced in accordance with the requirements of ASTM C1140 except that they shall have minimum dimension of 30 inches x 30 inches x 6 inches deep and shall have 45 degree sloped edges to permit escape of rebound. The panels may be constructed of wood or steel as specified in ASTM C1140.
2. The test panel must be securely fastened to a rigid structure to prevent vibration during placement.
3. Test panels shall be shot in vertical and horizontal (overhead) positions.
4. Test panels shall be field cured in the same manner proposed for the production shotcrete work until they are delivered to the laboratory or test specimens are extracted. During field curing, the panels shall be kept out of the sun and kept from freezing.
5. The Contractor shall core nine, 3-inch diameter samples from each test panel in the presence of the Engineer following the procedures in ASTM C 42 and ASTM C 1140. The minimum length of the core shall be equal to the diameter.
6. Core samples, for each set of test panels, will be taken at different times, corresponding to the specified strength ages in Section 2.03. Core samples shall be identified by mix designation, test panel number, and whether the test panel was vertical or horizontal. The cores shall be moist cured but not immersed, from the time they are taken to the time they are tested. The Contractor shall be responsible for pre-construction testing.

7. At least three specimens from each panel shall be tested for 24-hour, 72-hour and 28-day strength. The testing facility shall test the core for compressive strength in accordance with ASTM C1604/ C1604M.

8. At least three, 4-inch by 4-inch by 14-inch beams shall be extracted from each test panel of reinforced shotcrete in accordance with ASTM C1140 and shall be tested for flexural strength in accordance with ASTM C 1609/C 1609M. Beams shall be taken within two days of shooting test panels and wet cured until the time of the test.

9. The compressive strength of all cores from each test panel and flexural strength for the beam samples shall test to at least 100 percent of the strengths specified for each age in Section 2.03.

10. If the pre-construction test specimens fail to meet the performance requirements, the Contractor shall make the necessary adjustments in materials, mixture proportions, or application procedures and re-shoot the test panels. No shotcrete work shall commence until the pre-construction testing requirements have been met.

11. The exact proportions of ingredients determined on the basis of pre-construction tests shall be used in the actual application of shotcrete and shall not be varied without the written approval of the Engineer.

D. Construction Testing - Construction testing may be performed using test panels or coring of the in-place shotcrete or a combination of either method as determined by the Engineer.

1. Test cores shall be obtained from partially applied shotcrete or completed shotcrete at the Engineer's discretion. The Engineer will determine the locations and dates for test coring.

2. One construction test panel shall be made for every 50 cubic yards of shotcrete being placed. The test panels shall be constructed the same as the pre-construction test panels. The frequency of core sampling will average three cores for every 50 cubic yards of shotcrete placed. Additional cores may be sampled at the discretion of the Engineer.

3. Core sample collection shall be done following ASTM C 1140. The Contractor shall perform the core sampling and collect 3-inch diameter core samples. If any sample fails to meet the size requirements for the test, the Engineer shall select an alternative location from which to get a sample.

4. The average 28 day compressive strength of three cores taken from the test panels must equal or exceed the strength specified in Article 2.03 with no individual cores less than 0.85 times the strength specified in Article 2.03.

5. If one of a set of three samples taken in any section of the work or the average fails to meet the minimum compressive strength requirements, the Contractor shall core three additional samples from within five feet of the location of the failed sample. If one of these samples or the average of the three samples fails to meet the minimum strength criteria noted above, then remedial work shall be performed, including application of additional thickness of shotcrete or removal and replacement of the defective shotcrete as directed by the Engineer. Such additional sampling, testing, and remedial work shall be performed at no additional cost to the Owner.

6. Additional specimens may be required at any time by the Engineer. Should additional specimens show acceptable strength, the Contractor will be reimbursed for the cost of obtaining such additional samples. Should these specimens fail, the cost of additional specimens shall be deemed incidental to the work.

7. Flexural strength testing of production shotcrete will not be regularly required by the Engineer. However, the Contractor shall confirm the fiber content of the production shotcrete mix by determining the fibers in a known volume of production shotcrete using a method acceptable to the Engineer.

8. The voids caused by the coring shall be plugged by the Contractor.

9. If any cores taken fail to show adequate bond with the rock, or bond between layers, or show obvious defects, two additional cores shall be taken within approximately five feet of the unsatisfactory core. If either of these fails to show adequate bond with the rock or show obvious defects, the Engineer may require shotcrete in the area surrounding the unsatisfactory cores to be removed and replaced at no cost to the Owner.

10. If the shotcreting system selected by the Contractor fails to provide satisfactory in-place shotcrete in accordance with these Specifications, the Contractor shall immediately modify his procedures, mix design, equipment, or system to produce the specified quality.

1.05 SUBMITTALS

A. Submit the following information in accordance with the General Conditions and at least 60 days before the start of shotcrete placement;

1. Documentation of the qualifications and experience of shotcreting crew including the foreman and nozzleman.

2. Manufacturer's certifications showing source and proof of conformance to project specifications for all shotcrete materials including cement, silica fume, fly ash, aggregate (source, gradation, bulk density and absorption), water source, chemical admixtures, and fiber reinforcement.

3. Proposed source of shotcrete and shotcrete mixture proportions, including batch quantities of aggregate, cementitous materials, fibers, expected water demand, chemical admixtures, accelerator and proposed mix, proposed placing equipment, and methods of application.

4. Proposed methods for mixing, conveying, finishing, curing and testing along with a list of proposed equipment for each task.

5. Laboratory test reports of proposed mix and compatibility test results prior to first time use and any change in cement/additive/water source.

6. Details of proposed Safety Plan including description of personal protective equipment, description of procedures for handling potentially hazardous materials such as admixtures and accelerators, ventilation plan, communication plan, and plan for controlling dust and vapor.

B. After completion of laboratory testing and preconstruction testing and at least 28 days before application of shotcrete to the work, the following shall be submitted:

1. Laboratory report of strength tests on beams and cores from test panels that include;
   a. specimen identification, including mix designation and test panel number.
   b. date and time of application of shotcrete.
   c. date and time specimen was tested.
   d. curing time for each specimen.

e. dimensions of each specimen and sketch of specimen at failure.

f. load-deflection diagrams from flexural beam testing.

C. During construction:

1. Submit test samples from test panels or in-place coring.
2. Sample test results.
3. Shotcrete batch/delivery tickets as applicable.

D. Daily progress reports to the Engineer documenting shotcrete operations. The reports shall contain the following information, as a minimum:

1. The areas where shotcrete was placed each day by each nozzleman. Areas shall be indicated by station, elevation, and/or sketch, indicating volume placed. Identify nozzleman and foreman on each report.
2. The date and time each area was placed.
3. Maximum and minimum air temperature.
4. The curing and protective measures employed.
5. Estimate of the percentage of rebound.
6. Description of any special conditions or problems encountered.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials shall be stored in conformance with the manufacturer's recommendations.

B. Aggregate shall be stored so that deleterious substances and foreign matter are excluded, coarse and fine aggregate are kept separate, proper temperatures are maintained, and water contents are controlled by means of drainage and/or sheltering the piles from the weather.

C. Workers shall wear proper protective clothing and attend safety meetings pertaining to shotcrete operations.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement shall conform to ASTM C 150, Type I or Type III.

B. All mixing water for shotcrete shall be potable and meet the requirements of ASTM C 1602/C 1602M. Water quality shall be verified prior to use.

C. Silica fume shall comply with ASTM C 1240.

Admixtures shall comply with ASTM C 1141 and be certified as chloride free. Approval for the use of accelerators will be based on test results from test panels and cement-additive compatibility tests performed by the Contractor. Results of compatibility tests shall be submittedto the Engineer prior to shooting test panels. Admixtures shall be limited to the types specified and shall be added in the prescribed manner and dosage.

D. Fibers

1. Steel Fibers
   a. Shall conform to ASTM A820 and be suitable for production of ASTM C1116/ C116M Type I steel fiber reinforced shotcrete.
   b. Steel fiber shall be bent or deformed-end low carbon, cold drawn steel wire, Type I with a minimum tensile strength of 160,000 psi and a minimum length of 1 inch and a minimum aspect ratio of 40.
   c. Steel fibers shall be free of oil, grease, or other contaminants.
2. Synthetic Fibers
   a. Shall be suitable for production of ASTM C1116 Type III synthetic fiber reinforced shotcrete.
   b. Shall have a minimum length of 1 inch and a minimum aspect ratio of 40.
   c. Synthetic fibers shall be free of oil, grease, or other contaminants.

E. Aggregate shall be normal weight aggregate conforming to the requirements of ASTM C 33, except that the gradation of combined coarse and fine aggregate shall conform to Gradation No. 2:

U.S. Standard Sieve Size Square Mesh	Percent Finer By Weight
	Gradation 2
1/2-inch	100
3/8-inch	90 - 100
No. 4	70 – 85
No. 8	50 – 70
No. 16	35 – 55
No. 30	20 – 35
No. 50	8 – 20
No. 100	2 – 10
No. 200	0 – 5

F. Aggregate source or gradation shall not be changed during the course of the work without prior testing and approval by the Engineer.

2.02 EQUIPMENT

A. All equipment shall be operated, tested, and maintained in accordance with the manufacturer's instructions for the entire duration of the shotcreteing work.

B. Batching facility and proportioning devices shall provide exact amounts of ingredients in proportions required.

C. The shotcrete equipment shall be capable of feeding materials at a regular rate and ejecting shotcrete from the nozzle at velocities that will allow adherence of the materials to surface being shotcreted with a minimum of rebound and maximum adhesion and density.

D. For dry mixing process, placing equipment shall consist of a spray nozzle providing for ejection of materials and water in an intimate mixture.

E. For wet mixing process, accelerating admixtures shall be introduced into the shotcrete mix in the quantities permitted by means of a properly calibrated dispensing machine or dosage pump. Pumping shall ensure a continuous conveyance of base materials.

F. Equipment shall be provided to allow application of shotcrete to all surfaces at the appropriate distance from the nozzle and as perpendicular to the receiving surface as possible.

G. Dust shall be controlled by means of dust collectors and/or increased ventilation capacity in the vicinity of the workers.

2.03 MIX DESIGN REQUIREMENTS

A. The Contractor shall be responsible for developing the mix design for all shotcrete used on the Project that meets the strength requirements. The Engineer will inform the Contractor in writing of his approval of mixes that meet the requirements. No shotcrete mix shall be used that has not been accepted by the Engineer. Either wet or dry mix process shall be used. Shotcrete shall conform to the following criteria:

B. Compressive Strength

1. The mix design for shotcrete compressive strengths shall be such as to develop compressive strength progressively as follows:
   a. 1,100 psi minimum at 24 hours
   b. 2,100 psi minimum at 72 hours
   c. 5,000 psi minimum at 28 days
2. Compressive strengths stated above shall be for three-inch diameter test specimens tested following ASTM C1604 / C1604M.

C. Flexural Strength

1. Reinforced shotcrete shall have the following flexural strength properties determined in accordance and ASTM C1609/ C1609M. The tests shall be conducted on 4 inch by 4 inch by 14 inch long beam samples.
   a. minimum peak flexural strength, fp, at seven days, greater than or equal to 580 psi.
   b. minimum residual flexural strengths greater than or equal to:
      i) f100,0.5 - 290 psi
      ii) f100,2.0 - 170 psi

PART 3 - EXECUTION

3.01 QUALIFICATIONS FOR NOZZLEMEN AND MIXES

A. The mix design and nozzlemen proposed shall be considered satisfactory for use on the work if the following criteria are met:

1. All cored or broken surfaces are dense and free from laminations or sand pockets.
2. All reinforcing is completely encapsulated with shotcrete, and the shotcrete surrounding the reinforcing is dense and free from voids or honeycomb (applies only to panels or test sections containing reinforcing).

3. The average compressive strength of the cores and flexural strengths for the beam samples from each panel is at least equal to the strength criteria specified in Article 2.03 of this Section.

4. Test sections do not show excessive sloughage or rebound of material during placement.

5. In-place coring and sounding of test sections show proper bonding of shotcrete to rock.

3.02 BATCHING, MIXING AND SUPPLY

A. Wet mix shotcrete shall be batched, mixed and supplied using one of these methods; central mixing with transit mixture delivery; transit mixing and delivery; packaged, pre-blended, dry combined materials with water added on site. Volumetric batching will not be allowed.

1. Central mixing and supply
   a. Aggregate, cement and supplementary cementitious materials and fibers shall be mass batched in a central mix plant and delivered in a transit mixer in accordance with the requirements of ASTM C94 or C1116. Water and chemical admixtures shall be either mass or volumetrically batched. Weighing equipment shall be capable of batching to the accuracy specified in ASTM C1116 / C1116M.
   b. Add shotcrete materials, including fibers, in a sequence that ensures uniform mixing and dispersion.
   c. Transit mixers shall be free of accumulations of hardened concrete or shotcrete in the drum or blades. Transit delivery shall conform to the requirements of ASTM C94 / C94M.
   d. All shotcrete shall be shot within 90 minutes after addition of mixing water to the batch unless otherwise approved.

2. Transit mixing and supply
   a. The same requirements shall apply as specified for central mixing except that all ingredients shall be added directly to the transit mixer. Transit mixers shall be charged to no more than 70 percent of their rated capacity, to enable efficient mixing action.

3. Packaged, pre-blended, dry, combined supply
   a. The use of packaged supply with water addition at the site shall be permitted provided that the Contractor can demonstrate uniform mixing of the shotcrete and satisfactory conformance to all the Project performance requirements.
   b. Packaged shotcrete shall be mass-batched in conformance with the requirements of ASTM C1480 / C1480 M. All aggregates shall be dried to a moisture content of less than 0.1 percent by mass based on oven drying at 105° to 110° C.

B. Dry mix shotcrete shall be batched, mixed and supplied using one of these methods: site batching using mass batching units and rotary transit mixer supply, or packaged, pre-blended, dry, combined material supplied in bags.

1. Mass batching and supply: The same criteria shall apply as for central mixing and supply of wet mix shotcrete (Article 3.02 A.1), except that the bulk of the water shall be added at the water ring during the shotcrete application process, and all dry mix shotcrete shall be shot within 45 minutes of first contact of cement with moisture.

2. Packaged, pre-blended, dry, combined batching and supply
   a. Packaged shotcrete shall be mass-batched in conformance with the requirements of ASTM C1480. All aggregates shall be dried to a moisture content of less than 0.1 percent by mass based on oven drying at 105 to 110o C.
   b. Protect packaged shotcrete from exposure to moisture during handling, transport, and storage. Discard any bags that display lumps of pre-hydrated shotcrete.

3.03 SURFACE PREPARATION

A. All rock surfaces shall be scaled to remove loose rock prior to shotcrete operation.

B. Rock surfaces upon which shotcrete is to be placed shall be cleaned with air and/or water and shall be free from oil, standing or running water, mud, rebound, overspray, or other objectionable coatings that will prevent bonding of shotcrete to the rock. Rock surfaces receiving shotcrete shall be in a saturated-surface-dry condition just prior to placing shotcrete.

C. Certain rock conditions may require special preparations. Joints or seams having loose rock fragments or soft or swelling fillings shall be excavated and grouted or packed as directed by the Engineer. Joints or seams having clay or slick surfaces shall be cleaned and roughened to promote bonding of shotcrete.

D. Groundwater shall be controlled by means of grouting, installing drain pipes, panning, backdrains, underdrains, sandbagging, channeling, or other means accepted by the Engineer. Immediately before shotcrete placement, all rock surfaces shall be cleaned and water diverted to the satisfaction of the Engineer.

E. Non-corrosive measuring pins shall be installed on five foot centers to allow verification of shotcrete thickness. Other methods which permit direct measurement of the applied shotcrete thickness may be acceptable if the Contractor can demonstrate their reliability and compatibility with the Contractor's shotcreting activities.

3.04 APPLICATION OF SHOTCRETE

A. The amount of water used in each mix shall in no case be greater than that used for the same mix shot on a vertical surface. The Engineer may at any time require a demonstration that an excess of water is not being used, by shooting a test piece on a vertical surface.

B. Shotcrete shall not be placed when the ambient temperature is less than 40° F, except when measures approved by the Engineer are taken to maintain the temperature of the rock surface at or above 40° F for a minimum period of 48 hours prior to shotcreting.

C. Shotcrete shall be applied in accordance with good practice as outlined in ACI 506R. The nozzle shall be held at such distance and position that the stream of flowing material shall impinge as nearly as possible at right angles to the surfaces being covered and so that a minimum of rebound will fall on surfaces yet to be shot.

D. Precautions shall be taken to prevent overspray, rebound, or waste from being incorporated in the work area.

E. All rebound and waste shotcrete shall be removed and shall be disposed of in the designated disposal areas, as required by the Engineer. Rebound shall not be reclaimed for use in shotcrete.

F. All shotcrete shall be placed so that there will be no pockets of loose sand in any part of the work. Should any deposit of loose sand be covered with shotcrete, it shall be removed and replaced with acceptable shotcrete.

G. Shotcrete over the rock surface shall have a minimum thickness as shown on the Drawings.

H. Adequate ventilation and lighting shall be provided to the work area to ensure good visibility.

I. Construction joints shall be tapered over a minimum distance of 12 inches to a thin edge. The surface of the joint shall be thoroughly cleaned and wetted before additional shotcrete is placed on the joint.

J. Contractor shall coordinate with the Engineer to allow the geology to be mapped prior to shotcrete placement. The Contractor should assume that the mapping can be performed without delaying the shotcrete operation.

3.05 CURING AND PROTECTION

A. Initial Curing - Immediately after finishing, shotcrete shall be kept continuously moist for at least 3 days.

B. Final Curing - Additional curing shall be provided immediately following the initial curing and before the shotcrete has dried. One of the following materials or methods shall be used:

1. Continue the method used in initial curing.
2. Application of impervious sheet material conforming to ASTM C171.

C. Duration of Curing - Curing shall be continued for the first 7 days after shotcreting or until the specified compressive and flexural strength of the in-place shotcrete as determined by specimens obtained and tested in accordance with ASTM C42 is achieved.

D. Shotcrete shall be protected to maintain an internal temperature above 5° C until the specified 28-day strength is reached.

E. Before setting, shotcrete must be protected against running water, potential impact, and vibrations.

3.06 TESTS AND INSPECTIONS

A. The quality of in-place shotcrete will be monitored by the Engineer during placement. Improper placement techniques and areas of defective shotcrete shall be identified in the field for immediate correction and repair by the Contractor.

B. Final acceptance of in-place shotcrete shall be determined from tests on cores taken from the completed work or test panels as described in Article 1.04.

C. Shotcrete in-place shall be considered acceptable if it is: dense and free of laminations or sand pockets, there is no evidence of honeycomb or voids in the shotcrete, cores contain no evidence of poor bond between the substrate and the shotcrete, the thickness of shotcrete is as specified and as shown on the Drawings, the results of the strength testing from in-place shotcrete or test panels meet the requirements of Article 1.04 D.

D. If the results of the tests from the test panels or in-place work or assessment of the in-place shotcrete indicate non-conformance of the shotcrete to the specifications, the Engineer will implement a program of evaluation of the in-place shotcrete. The evaluation may include, but not be limited to, extraction of cores from the in-place work, and indirect methods to help assess the extent of defective areas.

E. Shotcrete that is non-conforming or defective shall be removed and replaced by the Contractor at no additional cost to the Owner.

3.07 FINISHED SHOTCRETE SURFACES

A. All unsound, honeycombed, poorly bonded, or otherwise defective shotcrete shall be removed as directed by the Engineer. Broken edges or abrupt changes in thickness shall be cut or chipped so that the roughened surface is tapered towards the center of the cavity. Additional shotcrete may be applied directly to a clean, moist, green shotcrete surface, but hardened shotcrete surfaces shall be prepared as outlined in ACI 506R and in a saturated-surface-dry condition just prior to placing shotcrete.

B. The surface finish on the specified profile shall be a gun finish, "as shot".

C. The core holes shall be patched by the Contractor with shotcrete materials premixed to the stiffest consistency that will permit tamping into place by use of hand or power rodding tools in accordance with ACI 301.

D. Remove and dispose of all rebound shotcrete and waste.

END OF SECTION 03361

SECTION 03414
PRESTRESSED CIRCULAR CONCRETE TANKS

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this section consists of furnishing all labor, equipment and materials required for the design, submittals, construction, and testing of the prestressed concrete wastewater equalization tank T-501 as shown on drawings and specified herein. The equalization tank layout shown on the drawings identifies the critical tank dimensions, wall, floor and roof penetrations and attached equipment and other information necessary to define the tank process requirements. It shall be the responsibility of the prestressed concrete tank contractor to provide the complete structural design for the tank wall and roof system with all openings and attachments and supports necessary for the process features shown on the drawings and identified herein. The structural floor with rock anchor layout has been designed in full by The Crom Corporation. The tank builder shall not deviate from the design presented herein.

B. The prestressed concrete tanks shall have prestressed walls in which a steel shell diaphragm of a height equal to the full wall height has been encased. All prestressing shall be done with high tensile steel permanently bonded to the tank wall.

C. The entire tank, including all portions of the floor, wall, and roof shall be built by the specialty tank contractor, using its own trained personnel and equipment.

1.02 REFERENCES

A. Standards of the following as referenced:

1. ACI 372R-03 – Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures.
2. AWWA D110-04 – Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks.
3. ACI 506R – Guide to Shotcrete.
4. ASTM A 821/A821M – Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.
5. ASTM A 1008/A1008M – Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy With Improved Formability.
6. ASCE Standard 7-05 – Minimum Design Loads for Buildings and Other Structures.
7. ASTM C 881/C881M – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
8. ASTM A 416/A416M – Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
9. ASTM A 884/A884M – Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement.
10. ASTM A 185 – Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

11. ASTM A 615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
12. ACI 305R – Hot Weather Concreting.
13. ACI 306R – Cold Weather Concreting.
14. ACI 350 – Building Code Requirements for Environmental Engineering Concrete Structures and Commentary.
15. ASTM C 31/C31M – Test Methods for Making and Curing Concrete Test Specimens in the Field.
16. ASTM C 39/C39M – Test Method for Compressive Strength of Cylindrical Concrete Specimens.
17. ASTM C 231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
18. ASTM C 143 – Standard Test Method for Slump of Hydraulic-Cement.
19. ASTM C 172 – Standard Practice for Sampling Freshly Mixed Concrete.
20. ASTM C 33/C33M – Specification for Concrete Aggregates.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section 01300 Submittals and shall include the following information:

1. Submit detailed design drawings showing all reinforcement, thickness of tank structure including floor, walls, dome and overcoat, location and details of all accessories required etc. sealed by a professional engineer registered in the state of Georgia.
2. Submit design calculations sealed by a professional engineer registered in the state of Georgia.
3. Submit mix designs for floor concrete mixes.
4. Submit mix designs for shotcrete mixes.
5. Submit mill test reports certifying the prestressing steel meets applicable ASTM standards.
6. Prestressing schedule including number and placement of prestressing wires on the tank wall and total applied force per foot of wall height.
7. Submit concrete strength reports for 7-day and 28-day breaks.
8. Project Record Documents: Record actual location layout and final configuration of tank and accessories on shop drawings and submit to engineer after construction of the tank is complete

1.04 QUALITY ASSURANCE AND QUALITY CONTROL

A. The prestressed concrete tank shall be designed and built in accordance with AWWA D110 Type II.

B. The Contractor shall retain a tank specialty contractor who shall be a specialist in the design and construction of circular prestressed concrete tanks. The tank specialty contractor shall have had

at least ten (10) years of experience in this specialty and have built, completely in its own name, in the past five (5) years, no less than ten (10) prestressed concrete tanks with concrete dome tops and steel shell design with epoxy injection procedure of comparable size demonstrating satisfactory service.

C. The specialty tank contractor's staff shall include a full-time professional engineer having no less than five (5) years of experience in the design and field construction of circular prestressed concrete tanks, who will be the responsible engineer in charge of the work to be done. All working drawings and design calculations shall carry the seal of such professional engineer registered in the State of Georgia.

D. The design and construction of all aspects of the floor, wall, prestressing and walkways of the prestressed concrete tank must be performed by the specialty tank contractor.

E. Prequalification:

1. All tank construction companies must be prequalified and meet the criteria stated in Section 1.04 of this specification to be considered an acceptable tank builder.
2. A complete prequalification package shall be submitted to the Engineer for consideration 21 days prior to the date set for receipt of bids. The prequalification submittal shall include the following items:
   a. Company's last two years financial reports or Balance Sheets and Profit and Loss Statements.
   b. Copy of fully documented Quality Assurance Program.
   c. Company personnel report indicating the following:
      i) Total number of employees by class (Superintendents, Tankbuilders, Nozzlemen, and Laborers) currently employed.
      ii) Number of employees, by class, available for project (state assumed date of construction commencement).
      iii) Number of anticipated temporary employees or new hires to be employed on project.
   d. Complete construction drawings showing the principal sizes, thicknesses, reinforcing size and spacing for all structural members including: floor, wall, dome shell and dome edge.
   e. Complete details of other structural appurtenances as required by the project drawings showing principal sizes, thickness and reinforcing sizes and spacing.
   f. Complete design calculations which address applicable loads provided in project documents.
   g. Experience record for 10 tanks of equal size (or larger) currently serving in the same capacity as the intended use for this project. The record shall include the size of the tank; tank service; name, address and telephone number of the Owner; the year of construction; and the name and telephone number of the Engineer for the project.
   h. Construction schedule which details the duration for tank construction.
3. The following are preapproved as acceptable tank construction companies:
   a. The Crom Corporation, Gainesville, Florida.

1.05 WARRANTY

A. The specialty tank contractor shall guarantee to the Owner the workmanship and materials on the entire tank structure for a period of five (5) years from date of acceptance of the work. In case leakage or other defects appear within the five (5) year period, the specialty tank contractor shall promptly repair the tank at its own expense upon written notice by the Owner that such defects have been found. Defects within the first year shall be considered warranty under the Contractors warranty responsibility. Leakage is defined as a stream flow of liquid appearing on the exterior surface of the tank, or leakage through the base slab, the source of which is from the inside of the tank.

1.06 DESIGN CRITERIA

A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R-03 Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures, AWWA D110 Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks, and currently accepted engineering principles and practices for the design of such structures.

B. The following loadings shall be utilized in the design:

1. The tank dimensions will be as shown on the contract drawings. The nominal tank working volume is 10 million gallons.
2. Fluid Loads: Shall be the weight of all liquid when the tank is filled to capacity the overflow elevation. The unit weight of the liquid material shall be 62.4 lbs/ft3.
3. Roof Live Loads: Consideration shall be given to all applicable roof design loads in accordance with AWWA D110, Section 3.3 and ASCE 7. The minimum roof live load for the structure shall be 12 psf.
4. Dead Loads: Consideration shall be given to all permanent imposed loads including concrete and steel.
5. Seismic Loads: Seismic load shall be calculated using the effective mass procedure as specified in AWWA D110.
6. Soil Pressure: Earth loads shall be determined by rational methods of soil mechanics. Soil pressure shall not be used in the design of the core wall to counteract hydraulic loads or provide residual compression in the wall.
7. Differential Backfill Loads: Forces from differential backfill loads shall be considered in the design and shall be based on the at-rest coefficient. Passive resistance shall not be used to resist differential backfill loads.
8. Wind Loads: Wind loads shall be considered in the design in accordance with ASCE 7.

PART 2 - PRODUCTS

2.01 CONCRETE

A. Concrete materials shall meet the requirements of ACI 301. Cement shall be Portland Type II or V.

B. Mix proportions shall be in accordance with ACI 301. Concrete or shotcrete in direct contact with prestressed reinforcement shall not contain chloride ions in excess of 0.06 percent of the weight of the cement in the mix.

C. Concrete for floor, footing and dome construction shall have a minimum 28-day strength of 4000 psi. Concrete for wall and walkway construction shall have a minimum 28-day strength of 4000 psi. Concrete cement content, aggregate size, water to cement ratio shall be determined by the tank designer.

D. A maximum of 25% of cementitious material may be fly ash

2.02 SHOTCRETE

A. Shotcrete materials shall meet the requirements of ACI 506. Cement shall be Portland Type II or V. A maximum of 25% of cementitious material may be fly ash.

B. Shotcrete shall have a minimum 28-day strength compressive strength, f'g, of 4000 psi.

C. Wet mix process referred to in ACI 506 for shotcreting shall be used.

D. All shotcrete in contact with diaphragm or prestressing wire shall be proportioned to consist of not more than three parts sand to one part Portland cement by weight. All other shotcrete shall be proportioned to consist of not more than four parts sand to one part Portland cement by weight.

E. Admixtures will not contain more than trace amounts of chlorides, fluorides, sulfides or nitrates.

2.03 REINFORCING STEEL

A. Non-prestressed mild reinforcing steel shall be new billet steel meeting the requirements of ASTM A 185 with a minimum yield strength, fy, of 60,000 psi.

B. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A 185 with a minimum yield strength, fy, of 65,000 psi.

2.04 PRESTRESSING STEEL

A. The prestressing wire shall conform to the requirements of ASTM A 821, Type B.

B. The prestressing wire size shall be 0.162" (8 gauge), 0.192" (6 gauge) or larger, but no larger than 0.250".

C. The ultimate tensile strength, fu shall be, 231,000 psi or greater for 8 gauge wire, 222,000 psi or greater for 6 gauge.

2.05 STEEL DIAPHRAGM

A. The steel diaphragm used in the construction of the core wall shall be 26 gauge conforming to the requirements of ASTM A 1008.

B. The steel shell is to be formed with re-entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm.

C. The sheets of steel diaphragm shall be continuous from bottom to top of wall; horizontal joints or splices will not be permitted.

D. All vertical joints in the diaphragm shall be rolled seamed, crimped and sealed watertight using epoxy injection.

E. In all tanks designed to use a waterstop at the floor/wall joint, the steel shell diaphragm shall be epoxy bonded to the waterstop.

2.06 PVC WATERSTOPS, BEARING PADS AND SPONGE FILLER

A. Plastic waterstops shall be extruded from an elastomeric plastic material of which the base resin is virgin polyvinyl chloride.

B. The profile and size of the waterstop shall be suitable for the hydrostatic pressure and movements to which it is exposed.

C. Bearing pads used in floor/wall joints shall consist of neoprene, natural rubber or polyvinyl chloride.

D. Sponge filler at the floor/wall joint shall be closed-cell neoprene.

2.07 EPOXY

A. Epoxy Sealants:

1. Epoxy used for sealing the steel shell shall conform to the requirements of ASTM C 881.
2. Epoxy used for sealing the steel shell shall be, Type III, Grade 1, and shall be a 100% solids, moisture insensitive, low modulus epoxy system.
3. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.
4. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC and steel.

B. Bonding Epoxy:

1. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to the requirements of ASTM C 881.
2. Epoxy resins shall be a two-component, 100% solids, moisture-insensitive epoxy and shall be Type II, Grade 2.

2.08 SEISMIC RESTRAINT CABLES

A. When required by design, seismic restraint cables shall be seven-wire strand conforming to ASTM A 416.

B. The strand shall be protected with a fusion-bonded, grit-impregnated epoxy coating conforming to ASTM A 882.

C. The minimum yield strength of the seven-wire strand shall be 270,000 psi.

2.09 ACCESSORIES

A. The specialty tank contractor shall furnish and install those accessories shown on the drawings.

B. Wall Manholes – A minimum of two, 1' 5" x 4' 4" rectangular Type 316 stainless steel wall manhole for access to the interior of the tank shall be provided. The cover and the bolts shall also be of Type 316 stainless steel. The wall manhole shall be designed to resist hydraulic loading without excessive deflection.

C. Wall sleeves shall be constructed of type 316 stainless steel. Tank nozzles shall be of orientation shown on drawings. Wall sleeve shall be provided with circular plate welded around sleeve in the factory.

2.10 COATINGS

A. An exterior coating system shall be provided. Tank coating shall be Tnemec Series 156 Enviro-Crete Modified Waterborne Acrylate. Color to be selected by the Owner.

PART 3 - EXECUTION

3.01 FLOOR

A. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.

B. A 6-mil polyethylene vapor-barrier shall be placed after subgrade preparation has been completed.

C. Form and screed boards shall be of proper thickness and sufficiently braced to ensure that the floor is constructed within proper thickness tolerances.

D. Plate bolsters shall be used to support reinforcing steel in the construction of the floor to ensure positive control of placement of reinforcing steel.

E. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.

F. The floor shall be continuously water cured for a minimum of 7 days.

G. The floor shall receive a light broom finish.

3.02 CORE WALL

A. The wall shall be constructed in a predesigned manner utilizing steel shell diaphragm, layers of shotcrete and prestressing wire with each conforming to the following:

1. Diaphragm Erection:
   a. The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the steel shell for erection or other purposes except for inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an epoxy sealant which complies with Section 2.8 Epoxy.

2. Shotcrete:
   a. All shotcrete shall be applied by or under direct supervision of experienced nozzlemen certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.
   b. Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.
   c. No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.
   d. No less than ⅛" thick shotcrete shall separate reinforcing steel and prestressing wire.
   e. The steel shell diaphragm shall be encased and protected with no less than 1" of shotcrete in all locations.
3. Curing:
   a. Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is started

3.03 EPOXY INJECTION

A. Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure.

B. Epoxy injection shall proceed only after the steel shell has been fully encased, inside and outside, with shotcrete.

3.04 DOME

A. All concrete shall be consolidated by means of a vibrator for proper encasement of reinforcing steel and welded wire fabric.

B. All surfaces at the joint between the wall and the dome shall be coated with bonding epoxy which complies with Section 2.8 Epoxy.

C. Plastic bolsters shall be used to support reinforcing steel and welded wire reinforcement to ensure positive control on placement of steel.

D. The exterior surface of the dome shall receive a light broom finish.

E. The dome shall be water cured for 7 days after casting or until dome band prestressing is completed.

3.05 PRESTRESSING

A. The initial tension in each wire shall be read and recorded to verify that the total aggregate force is no less than that required by the design. Averaging or estimating the force of the wire on the wall shall not be considered satisfactory evidence of correct placement of prestressing wires.

B. Placement of the prestressing steel wire shall be in a continuous and uniform helix of such pitch as to provide in each lineal foot of core wall height an initial force and unit compressive force equal to that shown on the design drawings. Splicing of the wire shall be permitted only when completing the application of a full coil of wire or when removing a defective section of wire.

C. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.

D. Prestressing shall be accomplished by a machine capable of continuously inducing a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing of the wire. In determining compliance with design requirements, the aggregate force of all tensioned wires per foot of wall

shall be considered rather than the force per individual wire, and such aggregate force shall be no less than that required by the design and as shown on approved drawings.

E. The tank construction company shall supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. The stress measuring equipment shall include: electronic direct reading stressometer accurate to within 2%, calibrated dynamometers and a test stand to verify the accuracy of the equipment.

F. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.

G. When multiple layers of wire are required, shotcrete cover between layers shall be no less than ⅛" thick.

3.06 COVERCOAT

A. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1" shall be placed over the prestressing wires.

B. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.

C. The covercoat shall receive a sliced trowel finish.

3.07 WALL OPENINGS

A. All wall pipes, sleeves and manholes passing through the wall shall be sealed to the steel shell diaphragm by epoxy injection.

3.08 COATINGS

A. Exterior coatings shall be applied in a minimum of two coats with a thickness of 4.0 to 8.0 MDFT per coat. The minimum total thickness of 10.0 MDFT.

B. All coatings shall be applied a minimum of 28 days after final application of concrete or shotcrete.

C. All application procedures for coatings shall be in accordance with manufacturer's recommendations.

3.09 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Concrete and Shotcrete Testing:
   a. Compression Tests:
      iv) Compression test specimens shall be taken during construction from the first placement of each class of concrete specified herein and at intervals thereafter as selected by the Engineer to insure continued compliance with these Specifications. At least one set of test specimens shall be made for each 150 yards of concrete placed and each 75 yards of shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.
      v) Compression test specimens for concrete/shotcrete shall conform to ASTM C 172 for sampling and ASTM C 31 for making and curing test cylinders. Test specimens shall be 6-inch diameter by 12-inch high or 4-inch diameter by 8-inch high cylinders.
      vi) Compression test shall be performed in accordance with ASTM C 39. Two test cylinders will be tested at 7 days and two at 28 days. The remaining cylinder will be held to verify test results, if needed.
   b. Air Content Tests:
      i) Air content tests shall conform to ASTM C 231 (Pressure Method for Air Content).
      ii) Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.
   c. Slump Tests:
      i) Slump tests shall be made in accordance with ASTM C 143.
      ii) Slump tests shall be made whenever compression test specimens are made.
2. Hydrostatic Testing:
   a. On completion of the tank and prior to completion of backfill placement at the footing or wall, the tank shall be tested for watertightness.
   b. The testing for watertightness shall be completed as follows:
      i) Fill the tank with water to the maximum water level and let it stand for a minimum of 24 hours.
      ii) Measure the drop in liquid level over the next 72 hours to determine the liquid volume loss for comparison with the allowable leakage. Evaporative losses shall be measured or calculated and deducted from the measured loss to determine the net liquid loss (leakage). The net liquid loss for a period of 24 hours shall not exceed 0.05 of 1 percent of the tank capacity.
      iii) If the leakage exceeds the maximum allowable, the leakage test shall be extended to a total of five (5) days. If at the end of five (5) days the average daily leakage does not exceed the allowable, the test shall be considered satisfactory. If the net liquid loss exceeds the maximum allowable, leakage shall be considered excessive and the tank shall be repaired and retested until leakage falls within the appropriate limits.
      iv) Damp spots on the exterior wall surface or measurable leakage of water at the wall base shall not be permitted. Damp spots are defined as spots where moisture can be picked up on a dry hand. The source of water movement through the wall shall

be located and permanently sealed in an acceptable manner. Leakage through the wall-base joint or footing shall likewise be corrected. Damp spots on the footing are generally to be expected, and are permissible.

3.10 CLEANING

A. The interior of the tank shall be cleaned to remove debris, construction items, and equipment prior to testing.

END OF SECTION 03414

SECTION 03450
ARCHITECTURAL PRECAST CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Decorative trim for installation in masonry.
2. Pre-cast concrete coping.
3. Connection devices.

B. Products furnished but not installed under this section:

1. Anchors for connecting precast concrete elements to structural framing.

C. Related Sections:

1. Cast-in-place concrete: Elsewhere in Division 3.
2. Joint sealers: Division 7.
3. Masonry: Division 4.

1.02 SUBMITTALS

A. Product Data: Submit fabricator's specifications, data, and instructions for manufactured materials and products, including the following:

1. Mix designs.
2. Test results for compressive strength.
3. Water absorption test results for exterior units.

B. Shop Drawings: Include complete information essential to proper fabrication and installation of precast units. Show dimensions, fabrication tolerances, and reinforcement sizes and locations, including locations and types of lifting devices required.

1. Show location of precast units and identification of each, corresponding to planned sequence of installation.
2. Designate welded connections by means of standard AWS symbols.
3. Provide locations and details of anchorages for installation in other work; furnish templates if required for accuracy.
4. Provide design calculations prepared by a professional structural engineer registered in the state in which the project is located.

C. Samples: Precast concrete panels not less than 12 inches square, illustrating finish color, quality, and texture.

1.03 QUALITY ASSURANCE

A. Codes and Standards: Comply with provisions of the following, except where exceeded by other requirements of the contract documents or of governing authorities:

1. ACI 301.
2. ACI 318.
3. ANSI/AWS D1.4.
4. CRSI Manual of Standard Practice.
5. PCI MNL-116.
6. PCI MNL-117.

B. Fabricator Qualifications:

1. Producer member of the Prestressed Concrete Institute (PCI) or participant in PCI's Plant Certification Program.

C. Fabrication Requirements:

1. Design units to support loads indicated and as required by applicable code requirements.
2. Produce required units at precast concrete fabricating plant; site-produced units are not acceptable.

D. Erector Qualifications: Firm with not less than 5 years of experience in the successful erection of precast units comparable to those specified.

E. Mock-ups: Prepare one full-size sample of each precast concrete unit type and erect on project site for the Architect/Engineer's inspection and approval prior to start of fabrication.

1. Patching: Damage an area on exposed face surface and demonstrate to the Architect/Engineer materials and methods proposed for minor repairs. If demonstration is acceptable to the Architect/Engineer, repairs matching approved sample repair will be allowed in the work. Otherwise, removal and replacement of damaged units will be required.
2. When directed by the Architect/Engineer, remove mock-ups from project site; they may not be incorporated in the work.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver precast concrete units to ensure continuity of installation. Store to prevent damage such as cracking, distortion, or staining, and to maintain visibility of markings. Handle and support units using only designated lift points and lifting devices.

PART 2 - PRODUCTS

2.01 FORMWORK

A. General: Construct forms accurately to size, mortar-tight, and of sufficient strength to withstand all fabrication operations without distortion of precast units.

B. Tolerances: Maintain formwork to provide finished units within fabrication tolerances specified in PCI MNL-116.

C. Facing Materials, General: Provide form facings of metal, plastic, or other nonreactive material that will produce required concrete finish.

2.02 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed except where plain bars are indicated.

B. Steel Wire: ASTM A 82, plain cold-drawn.

C. Welded Wire Fabric: ASTM A 185, plain cold-drawn steel.

D. Reinforcing Accessories:

1. Tie wire: Black annealed type, 16-1/2 gage or heavier.
2. Supports: Bar supports conforming to specification of CRSI's Manual of Standard Practice.
   a. Class 1 (plastic protected) at all formed surfaces which will be exposed to weather.
   b. Class 1 (plastic protected) or Class 2 (stainless steel protected) at all formed surfaces which will be exposed to view but not to weather.

2.03 CONCRETE MATERIALS

A. Portland Cement: ASTM C 150, and as follows:

1. Type I or Type III, except where other type is specifically permitted or required by the contract documents.

B. Aggregates:

1. Normal weight: ASTM C 33.
2. Structural lightweight concrete: ASTM C 330.

C. Water: Potable.

D. Admixtures - General: Admixtures which result in more than 0.1 percent of soluble chloride ions by weight of cement are prohibited.

E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other admixtures specified.

F. Water-Reducing Admixture: ASTM C 494, Type A.

G. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

H. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.

I. High-Range Water-Reducing Admixture (Superplasticizer): ASTM C 494, Type F or G.

2.04 CONNECTION MATERIALS

A. Steel Welding Plates: ASTM A 283; Grade C, structural quality.

B. Steel Shapes: ASTM A 36.

C. Steel Finish: Hot-dip galvanize after fabrication components that will be exposed to weather, in accordance with ASTM A 153. Components that are cast into precast units and exposed to view but not to weather may be cadmium coated, electro-galvanized, or hot-dip galvanized. Other steel components may be coated with fabricator's standard rust inhibitor paint.

D. Anchor Bolts: ASTM A 307, Grade C.

E. Welding Electrodes and Fluxes: AWS D1.1, types as required by materials being welded.

F. Accessories: Hangers, clips, and other items required for installation of precast units and support of related construction.

2.05 CONCRETE MIX DESIGN

A. General: Prepare design mix of concrete on the basis of either field experience or trial mixtures, as specified in ACI 301.

B. Review: Do not begin concrete production until proposed mix has been reviewed by the Architect/Engineer.

C. Mix: Design mix to achieve properties of concrete as follows:

1. Compressive strength: 6000 psi minimum at 28 days.

D. Mix Adjustments: Provided that no additional expense to owner is involved, Contractor may submit for Architect/Engineer approval requests for adjustment to approved concrete mixes when circumstances such as changed project conditions, weather, or unfavorable test results occur. Include laboratory test data substantiating performance characteristics with mix adjustment requests.

E. Admixtures:

1. Air-entraining admixture: Use in accordance with ACI 301 for maximum size of coarse aggregate.
2. Water-reducing admixtures: Use in strict compliance with manufacturer's directions and in amounts suitable for weather conditions prevailing at time of placement.

2.06 FABRICATION

A. General: Fabricate architectural precast concrete units in compliance with PCI MNL-117. Adequately reinforce units to resist stresses due to transporting and handling.

B. Built-in Anchorages: Locate accurately and secure to formwork. Position to avoid interference with main reinforcement or placement of concrete; do not relocate without the Architect/Engineer approval.

C. Openings: Cast openings with minimum dimension of 10 inches or larger. Smaller openings may be field cut as required, with the Architect/Engineer prior approval.

D. Release Agent: Provide either form materials with permanent factory-applied nonabsorptive liner or form coating. If form coating is used, thoroughly clean and recondition formwork and reapply coating before each use. Rust on form surfaces is unacceptable.

E. Reinforcement: Clean reinforcement of loose rust and mill scale, soil, and other materials which adversely affect bond with concrete. Place reinforcement to achieve not less than minimum concrete coverages required for protection, and accurately position, secure, and support against displacement. Set wire ties completely embedded in concrete without contact with or penetration of exposed concrete surfaces.

F. Concrete: Place continuously for each unit, complying with requirements of ACI 304. Consolidate concrete by vibration while avoiding damage to or dislocation of reinforcement, anchorages, and built-in accessories.

G. Identification: Mark units to identify pickup points and final orientation, corresponding to final shop drawings. Imprint fabrication date on each unit in concealed location.

H. Architectural Finish: Fabricate exposed faces of architectural precast concrete units to achieve finish as follows:

1. Smooth, off-the-form finish, free of pockets, sand streaks, and other surface blemishes.
2. Match Architect/Engineer's control samples.

I. Provide as-cast or float finish for surfaces which will be concealed.

2.07 SOURCE QUALITY CONTROL

A. Non-Conforming Work: Replace precast concrete units which do not conform to specified requirements, as directed by the Architect/Engineer and pay for corrections to other work necessitated by such replacement.

1. Dimensions: Precast concrete units smaller than allowed by specified tolerances will be rejected. Units larger than specified tolerances will be rejected if they interfere with other construction or if, in the opinion of the Architect/Engineer, the appearance of the work is adversely affected.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Comply with erection recommendations of PCI MNL-127. Provide temporary shoring, bracing, and connections as required to maintain stability of structure and precast units during construction, arranged to avoid interference with subsequent precast unit installation.

B. Anchor Bolts: Clean bearing and contact surfaces before assembly. Set precast units with bearing plates accurately, using wedges, shims, or setting nuts as required. After tightening anchor bolts and ensuring that members are plumb, grout solidly between plates and bearing surfaces.

C. Welding: Comply with requirements of AWS D1.1.

1. Protect adjacent concrete surfaces from damage due to weld splatter, smoke staining, or excessive heat that can lead to spalling, using noncombustible shields.
2. Remove slag and coat metal surfaces affected by welding immediately after completing welding in each area. Use zinc-rich coating for galvanized connections and a good quality rust inhibitive primer for non-galvanized connections.

D. Erection Tolerances: Do not exceed tolerance limits specified in PCI MNL-127.

E. Grouting Joints: Grout open joints after precast units have been placed, properly aligned, and permanently secured in position. Use formwork if required to avoid leaks and maintain grout in proper position until it has cured. Strike off unformed grout surfaces flush with adjacent surfaces. Do not allow grout to dry prematurely.

3.02 FIELD QUALITY CONTROL

A. General: Conduct inspections, perform testing, and make repairs or replace unsatisfactory precast units as required. The Architect/Engineer may reject architectural precast panels for any of the following reasons:

1. Specified tolerances exceeded.
2. Damage to panels.
   a. Patching of damage to exposed faces is subject to the Architect/Engineer's approval.
3. Surface finish deficiencies in exposed faces.
4. Other defects as listed in PCI MNL-117.

3.03 CLEANING

A. Clean exposed faces of precast units after all joint treatment has been completed, following recommendations of precast fabricator. Provide protection to adjacent surfaces which could be damaged by cleaning materials or methods.

END OF SECTION 03450

SECTION 03600
GROUT

PART 1 - GENERAL

1.01 SCOPE

A. Contractor shall furnish all labor, materials, equipment, and incidentals required to provide grout as shown and specified.

B. Grout shall be placed at the following locations:

1. Pipe Railing.
2. Dowelling.
3. Weir and Slide Gates.
4. Grating.
5. Concrete Patchwork.
6. Anchor Bolts.
7. Waterstops.
8. Precast to concrete structures.
9. Under baseplates.

C. The types of grout include the following:

1. Non-shrink, epoxy type.
2. Non-shrink, non-metallic type.
3. Ordinary cement-sand.
4. Refer to Section 03300 for pressure grouting applications.

1.02 SUBMITTALS

A. Shop Drawings: Submit copies of manufacturer's specifications and installation instructions for all proprietary materials.

B. Reports and Certificates:

1. For proprietary materials, submit copies of reports on quality control tests.
2. For nonproprietary materials, submit certification that materials meet specification requirements.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ASTM C 150, Portland Cement.

2. ASTM C 109, Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).
3. ASTM C 191, Time of Setting of Hydraulic Cement by Vicat Needle.
4. CRD-C 588, Specifications for Non-Shrink Grout.

1.04 PRODUCT DELIVERY. STORAGE AND HANDLING

A. Delivery of Materials: Grout materials from manufacturers shall be delivered in unopened containers and shall bear intact manufacturer's labels.

B. Storage of Materials: Grout materials shall be stored in a dry shelter and shall be protected from moisture.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Non-metallic, cartridge style, 100 percent solids, high strength epoxy grout.

1. Product and Manufacturer: Speed Bond #1 as manufactured by Prime Resins Inc.
2. Hilti.
3. Simons.
4. Red Head.
5. Or Equal.

B. Non-Shrink, Non-Metallic Grout

1. Pre-mixed non-staining cementitious grout requiring only the addition of water at the jobsite meeting ASTM C-827 and CRD C-621.
2. Product and Manufacturer:
   a. Sikagrout 212 by Sika Corp.
   b. Masterflow 713 by Master Builders Company.
   c. Non-Ferrous Non-Shrink Grout by the Burke Company.
   d. Non-Shrink, Non-Metallic Grout as manufactured by W. R. Meadows.
   e. Or Equal.

C. Ordinary Cement-Sand Grout:

1. Except where otherwise specified use 1 part cement to 3 parts sand complying with the following:
   a. Cement: ASTM C 150, Type II.
   b. Sand: ASTM C 33.
2. For water repelling and shrinkage reducing requirements use admixtures.
   a. Product and Manufacturer:
      i) Integral Waterpeller by The Euclid Chemical Company.
      ii) Omicron, Type OM by Master Builders Company.

iii) Hydrocide Powder by Sonneborn-Contech.

iv) Or Equal.

3. For use at horizontal waterstops only.

D. Water: Use clean, fresh, potable water free from injurious amounts of oils, acids, alkalies or organic matter.

E. Epoxy Resin Adhesive:

1. Two part mix 1:1.
2. Hilti.
3. Simons.
4. Red Head.
5. Manufacturer: Sika Corp - Sikadur 32, Hi-Mod (Horizontal joints), Sikadur 31 Hi-Modgel (Vertical joints) or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Specifications do not proceed until Engineer provides clarification.
2. Drypacking will not be permitted unless approved by the Engineer.
3. Manufacturers of proprietary products shall make available upon 72 hours notification the services of a qualified, full time employee to aid in assuring proper use of the product under job conditions.
4. Placing grout shall conform to temperature and weather limitations in Section 03300.
5. Surface to be grouted is to be adequately cured, cleaned dampened and roughened per manufacturer recommendations to ensure adequate bonding.

B. Pipe Railings

1. After posts have been properly inserted into the holes or sleeves, fill the annular space between posts and sleeve with the non-shrink, non-metallic grout. Bevel grout at juncture with post so that moisture flows away from post.
2. Do not grout railing designated as "removable sections".

C. Grout for Dowelling and Anchor Bolts

1. Epoxy resin Adhesive may be used in accordance with manufacturer's recommended application.
2. Reference Section 03605.

D. Grouting for Waterstops

1. Grout for PVC waterstops to be the non-shrink, non-metallic type. Refer to Section 03250 for installation procedures.
2. Grout from Redi-mix plant conforming to applicable requirements of Section 03300 may be substituted at no additional compensation to the Contractor.

E. Grouting for Weir and Slide Gates: Provide minimum of 1" thickness of non-shrink, non-metallic grout under frames. Gates to be coated with an approved epoxy coating per Section 09900 prior to installing and grouting.

F. Grouting for Bearing Plates and Equipment: Use non-shrink, non-metalic grout for setting bearing plates and equipment. Provide a minimum grout thickness of 1".

G. Patchwork at Demolition Areas

1. Furnish and install non-shrink, non-metallic grout for dry packing as required to patch all mechanical, electrical and miscellaneous penetrations which are either designated to be patched or are the result of abandoned, removed or relocated material and equipment. Prepare surface and place grout as recommended by manufacturer and as specified. Finish grout off flush with existing surface.
2. Reinforce with approved wire mesh and use approved structural concrete for penetrations larger than 1/2 square feet. Conform to requirements of Sections 03100, 03200 and 03300.

END OF SECTION 03600

SECTION 03605
DOWELING INTO EXISTING CONCRETE

PART 1 - GENERAL

1.01 SCOPE

A. Contractor shall furnish all labor, materials, equipment and incidentals required to place reinforcing dowels into existing concrete using a two-component epoxy adhesive as shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product Data: Furnish technical data for epoxy adhesives, grouts, and bonding agents suggested for the Project work including installation instructions, independent laboratory test results, and handling and storage instructions.

B. Samples: Furnish two random samples of each batch of products delivered to Project site, for independent testing.

C. Quality Control Submittals: Furnish the following:

1. Manufacturer's past project experience data on at least three similar projects supplied with proposed products within the last 3 years, to include client name, address, contact person, phone number, project location, and description of work.
2. Batch test reports for each batch of product delivered to site. Provide manufacturer's written certification that each batch delivered meets these Specifications, the intended uses on project, including capability to bond to damp or wet concrete surfaces. Certification shall include batch test results for each product.
3. Manufacturer's written letter of certification identifying Contractor's employees qualified for operation of manufacturer's equipment and certified for installation of products, trained through jobsite instruction conducted by manufacturer.
4. Copy of manufacturer's equipment service and repair manuals for each type of equipment delivered to project site.
5. Copy of manufacturer's service agreement with Contractor for each type of equipment.
6. Procedures for testing and verifying product meets specified requirements.
7. Special Inspection: Provide detailed step-by-step instructions for the special inspection procedure as required by ICBO reports and Section 306 of the Uniform Building Code.

1.03 QUALITY ASSURANCE

A. Contractor shall examine the conditions under which reinforcing dowels are to be placed into existing concrete, and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

B. Reference Standards: Comply with applicable provisions and recommendations of the latest edition of the following, except as otherwise shown or specified:

1. ACI 301, Specifications for Structural Concrete For Buildings.
2. ACI 305, Hot Weather Concrete.
3. ACI 318, Building Code Requirements for Reinforced Concrete.
4. ACI 350, Environmental Engineering Concrete Structures.
5. ACI 347, Recommended Practice for Concrete Formwork.
6. ICBO Report No. 4398, April 1988 for Adhesive Technology Corp.

1.04 MANUFACTURERS' SERVICES

A. Furnish manufacturer's representative to conduct jobsite training for proper installation, handling, and storage of each product delivered to Project site, for personnel who will perform actual installation. Engineer will attend training sessions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Items of Materials: End products should be from one manufacturer in order to achieve structural compatibility, singular responsibility, and standardization for maintenance, and replacement.

B. Epoxy Adhesive for Doweling

1. Meet ASTM C 881, Type 1, Grade 3, Class A, B, or C, depending on site conditions.
2. Hilti.
3. Sika.
4. Two-component, 100 percent solids, nonsag, paste, insensitive to moisture, designed to be used in adverse freeze/thaw environments and gray in color.
5. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
6. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precaution.

C. Component "A" Base Resin

1. Modified biphenyl-A type epoxy.
2. Viscosity: Light paste, 350 cps maximum prior to mixing to ensure proper wetting of moist concrete surfaces.
3. Fillers: 100 percent solids, fumed silica and selected annular micro silica powders. Do not use micro spheres, fly ash, or asbestos.
4. Color: White.

D. Component "B" Hardener or Curing Agent

1. Viscosity: Light paste.
2. Fillers: 100 percent solids, fumed silica and selected annular micro silica powders. Do not use micro spheres, fly ash, or asbestos.
3. Color: Black.

E. Mixed Epoxy Adhesive

1. Nonsag light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runout, holding the following properties:
   a. Slant Shear Strength, ASTM C 881/882, No Failure in Bond Line, Dry/Moist Conditions: 5,000 psi.
   b. Compressive Strength, ASTM D 695: 14,000 psi, minimum.
   c. Tensile Strength, ASTM D 695: 4,500 psi.
   d. Heat Deflection Temperature, ASTM D 648: 135 degrees F, minimum.
2. Manufacturers:
   a. Adhesives Technology Corp, 4210 B Street, N.W., Suite D, Auburn, WA 98001, Anchor-It Fastening Systems, HS 200 Epoxy Resin, telephone 1-800-262-4748.
   b. Or equal.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Epoxy Components:

1. Store epoxy components on pallets or shelving in a covered storage area with locking door.
2. Control temperature above 60 degrees F and dispose of product if shelf life has expired.
3. If stored at temperatures below 60 degrees F, test components prior to use to determine if they still meet specified requirements.

3.02 GENERAL

A. Dispensing, Metering, or Mixing Epoxy Adhesive Components: Use portable, automatic metering and mixing device or machine capable of maintaining prescribed mix ratio within deviation of 5 percent or less, by volume.

B. Dispense epoxy components through specially designed static mixing nozzle that thoroughly mixes epoxy components and places mixed epoxy at base of predrilled hole.

C. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

D. Where large meter and mixing pumps are impractical, provide epoxy adhesive packaged as follows:

1. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
2. Dispense components through a mixing nozzle that thoroughly mixes components and places epoxy at base of predrilled hole.
3. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate sizes of reinforcing dowels.

3.03 TESTING OF AUTOMATIC METERING AND MIXING DEVICES

A. Tests for Proper Ratio:

1. Retain small amount of dispensed adhesive for inspection after each time the pump is refilled.
2. Operator shall check these samples for color change.
3. Should change in color occur, operator shall follow manufacturer's service instructions to obtain proper operation.

B. Frequency of Tests: Make full ratio check after each 100 gallons of adhesive is dispensed or if color of mixed adhesive becomes noticeably darker or lighter.

C. Ratio Check Procedure:

1. Disconnect dispensing head behind ON/OFF valve.
2. Place a 1-cup volume container and a 2-cup volume container under the "B" and "A" component hose ends.
3. Actuate the pump until both cups are filled to a proper proportion of 2:1 by volume.

3.04 DOWEL SIZING AND INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes: Electric or pneumatic rotary type with medium or light impact.
2. Hollow drills with flushing air systems are preferred.
3. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.

B. Hole Diameter

1. As small as possible to allow dowel to be embedded to required depth.
2. Use drill bit diameter meeting ICBO report requirements.
3. Hole Diameter: Dowel diameter plus 1/8 inch for temperature at time of installation above 60 degrees F, or dowel diameter plus ¼ inch for temperature at time of installation below 60 degrees
4. For large reinforcing bars No. 8 or greater embedded 18 diameters or more, verify hole diameter with manufacturer.

C. Obstructions in Drill Path

1. When existing reinforcing steel is encountered during drilling and when approved by the Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter; or redrill hole 1 inch from original location, beginning in the same line at the surface, redirecting the drill to miss reinforcing steel.
2. Place dowels in both the misdrilled hole and the new one.
3. Dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.
5. Bent Bar Dowels: Where edge distances are critical, and striking reinforcing steel is likely, drill hole at 10 degree angle or less and use prebent reinforcing bars.
6. Conform to details shown.
7. Do not install prior to receiving manufacturer onsite training.

D. Dowel Embedment Depth: Install to depth and spacings shown.

END OF SECTION 03605

SECTION 04400
MASONRY

PART 1 - GENERAL

1.01 SCOPE

A. Furnish all labor, materials, equipment and incidentals required to construct all masonry work as shown on the Drawings and specified herein.

B. The work under this Section includes, but is not necessarily limited to, the following:

1. Concrete masonry units (CMU).
2. Reinforced CMU lintels.
3. Masonry reinforcing, ties and anchors.
4. Grouting required throughout the project.
5. Cavity wall insulation.
6. Splash blocks.
7. Membrane flashing.
8. Metal drip edge.
9. Mortar net.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Section 03600 – Grout

B. Section 04255 – Masonry Veneer Systems

C. Section 05500 – Miscellaneous Metal.

D. Section 07280 – Air/Vapor Barrier Membrane

E. Section 07900 - Caulking and Sealants.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. 2 samples each of concrete masonry units.
2. Before commencing with the layout of any architectural masonry, construct sample masonry panel(s) for brick and/or concrete masonry exposed in finished work. Build panel(s) 4 ft. long x 2 ft. long x 6 ft. high by the required thickness as indicated on the drawings, with facing brick on one side, and concrete masonry units on other side and incorporating joint reinforcement, vertical control joint, specialty shapes, insulation, air vapor/barrier membrane, accessories, weepholes and flashings, face units and backup units as indicated.

a. Construct sample panel at project site location designated by the Engineer to allow acceptance by the Engineer prior to start of masonry work. Sample panel(s) shall not be built in, or as part of the structure, but shall be located where directed.

b. Construct sample panel(s) using specified materials and methods of construction, conforming to indicated shape, surface finish, color and texture range, mortar color, bond pattern, and joint finish.

c. Upon acceptance by the Engineer, sample panel(s) shall become the standard of workmanship and acceptance for represented masonry work. Do not start masonry work for which sample panel(s) are required until sample panel(s) have been accepted.

3. Manufacturer's specifications and instructions for each manufactured product including, but not limited to, pigments, etc. Indicate that copy of each applicable instruction has been distributed to the Masonry Installer if other than the Contractor.

1.04 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the latest edition following, except as otherwise shown or specified.

1. NCMA National Concrete Masonry Association.
2. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile; 2009.
3. ASTM C126 - Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units; 2010.
4. ASTM-C-90, C-140, Concrete Masonry Units.
5. ASTM-C-426, Linear Drying Shrinkage.
6. UL618, Standard for Concrete Masonry Units.
7. ASTM A-82, Cold Drawn Steel Wire Reinforcement.
8. ASTM C-150, Requirements for Portland Cement.
9. ASTM C-207, Hydrated Lime.
10. ASTM C-144, C-33, Sand.
11. ASTM C-270, Mortar.
12. ASTM C-476-71, Grout.
13. ASTM C-615, Reinforcing Bar.

1.05 PRODUCT DELIVERY. STORAGE AND HANDLING

A. All perishable materials for the work of this Section shall be delivered, stored and handled so as to preclude damage of any nature. Manufactured materials, such as cement and lime, shall be delivered and stored in their original containers, plainly marked with identification of material and maker. Materials in broken containers, or in packages showing water marks or other evidence of damage, shall not be used and shall be removed from the site.

B. All masonry shall be shipped stacked with hay or straw protection or other suitable protective device, and shall be similarly stacked off the ground on the site in a dry location. In addition, all

masonry stored on the site shall be protected from the weather and staining with the use of tarpaulins or other covering approved by the Engineer. If units become wet, do not install until they are dry.

C. Mason's sand shall be protected during shipping, storage and while on job site to prevent contamination.

1.06 COLD WEATHER CONSTRUCTION

A. Masonry construction in cold weather shall conform to the applicable requirements of "Cold Weather Concrete Masonry Construction" of the National Concrete Masonry Association (NCMA).

1.07 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS - MASONRY

A. Concrete Masonry Units

1. Concrete masonry units (CMU) shall conform to ASTM-C-90, normal weight, Grade N, Type II, in color; "natural gray", hollow, load bearing units of 8-in x 16-in nominal face size and bed dimension as shown on the Drawings. All exposed vertical corners shall be bull nosed.
2. CMU shall be free from substances that will cause staining or pop-outs, and shall be fine, even textured wet steam cured for at least 18 hours and then air cured in covered storage for not less than 28 days before delivery. Units shall have a maximum linear drying shrinkage of 0.25 percent (ASTM C-426) and have a moisture content at time of delivery not exceeding 30 percent of total absorption.
3. Units shall be obtained from one manufacturer to insure even color and texture.
4. Provide special units required by the Drawings, including solid, corner, lintels, and jamb units.

2.02 REINFORCING, TIES, AND MISCELLANEOUS

A. Joint Reinforcement Manufacturers:

1. Dur-O-Wal, Inc.
2. Hohmann & Barnard, Inc.
3. Or equal.

B. General:

1. Prefabricated, formed of ASTM A82 cold-drawn steel.
2. Hot-dip galvanized, ASTM A153, Class B-2.

3. Provide reinforcement fabricated of 9 gage deformed side and 9 gage smooth cross wires flush welded together on 16-in. centers.
4. Provide prefabricated special pieces for corners and intersections of walls and partitions.
5. Provide joint reinforcing width according to width and type of wall indicated on drawings.

C. Exterior Cavity Walls:

1. Provide continuous truss type reinforcement with adjustable eye-wire tie system at inside wythe and one longitudinal wire at exterior veneer.
2. Provide 3/16-in. hot-dipped rectangular pintles and 9 gage clip to engage pintle and longitudinal wire in exterior veneer.

D. Single Wythe Walls:

1. Provide truss type reinforcement with two longitudinal wires.

E. Flexible Ties Manufacturer:

1. Manufacturers:
   a. Vee Wall Tie No. VWT and No. 359 Weld-on rod by Hohmann & Barnard, Inc.
   b. Triangle Wire Tie No. 316 and No. 315 weld-on rod by Heckmann Building Products, Inc.
   c. Flex-O-Lok with Type A Weld-on rod by AA Wire Products Co.
   d. Or acceptable equivalent product.
2. Provide flexible ties to tie masonry to steel framing members.
3. Wire Ties: 3/16 in. diameter galvanized, ASTM A153, Class B-2 wire, length to suit job conditions.
4. Weld-On Rods:
   a. 1/4 in. diameter steel wire.
   b. 9 in. overall with a 3/8 in. offset and 4 in. adjustment.

2.03 MORTAR & GROUT MATERIALS

A. Portland cement shall conform to ASTM C150 Type I or II.

B. Lime for masonry mortar shall be hydrated, conforming to ASTM C207, Type S.

C. Sand shall be clean, durable particles, free from injurious amounts of organic matter. The sand shall conform to the limits of ASTM C144. Sand for grout shall conform to ASTM C144 or C33 as required. All Mason's sand to be shipped from one supplier all at once.

D. Water shall be free from injurious amounts of oils, acids, alkalis or organic matter, and shall be clean and fresh.

E. Mortar shall conform to ASTM C270, Type S, consisting of 1 part portland cement, 1/2 part lime, 4-1/2 parts sand, or as otherwise approved by the Engineer. Ingredients shall be accurately measured by volume in boxes especially constructed for the purpose by the Contractor. Measurement by shovel will not be allowed.

F. Colored mortar not required for interior CMU's. .

G. Grout for setting bearing plates, machinery, or any other equipment shall be mixed as recommended by the manufacturer to give the necessary consistency for placing and to give a minimum compressive strength of 3,000 lbs. per square inch in three (3) days.

H. All other grout shall be 1 part Portland cement and 1 part sand.

I. Non-shrink grout shall utilize Embeco Aggregate as manufactured by the Masters Builders Company, Ferrolith by Sonneborn, or equal and shall be proportioned with sand in strict accordance with the manufacturer's instructions for the use intended.

J. Do not use calcium chloride or surfactants in mortar or grout.

2.04 SPLASH BLOCKS

A. Cast-in-place or precast using concrete having a minimum 28 day compressive strength of 3000 psi as specified under Section 03300 except that maximum size aggregate is 5/8 in. and slump is between 1-1/2 in. and 3 in. Provide splash blocks 18 in. x 24 in. by 4 in. thick with sloping, displayed drainage recess cast in top surface, and reinforced with 4 in. by 4 in. 10/10 welded wire mesh.

2.05 LINTELS

A. General:

1. Provide lintels to extend at least eight inches beyond each jamb of the masonry opening.
2. Provide lintels with all surfaces free of cracks, chips, and broken edges.
3. Provide lintels sized for wall thickness and masonry opening and with 3/8-in. allowance in height, width, and length for mortar joints.

B. Block Lintels:

1. Provide block lintels fabricated from standard lintel-type concrete masonry units of same material and texture as units in adjoining work, reinforced as indicated, and filled with grout having a minimum 28 day compressive strength of 2,500 psi as specified.

C. Steel Lintels:

1. Install galvanized steel lintels as specified under Section 05500.

2.06 VERTICAL REINFORCEMENT

A. Contractor shall furnish vertical reinforcement and dowels as specified under Section 03200.

2.07 CAVITY WALL INSULATION

A. Extruded, closed cell, polystyrene.

B. ASTM C578, Type IV. Factory Mutual approved for a Class I, fire rating.

C. R-Value: 6.7 in accordance with ASTM C518.

D. Compressive Strength: 25 lb./in.2 minimum in accordance with ASTM D1621.

E. Provide in thickness as indicated.

2.08 MEMBRANE FLASHING

A. Provide 40 mil thick thru-wall flashing consisting of a 36 mil self-adhering rubberized asphalt membrane laminated to an 4 mil high density polyethylene film with silicone treated release sheet.

B. Products:

1. CCW-705-TWF Thru-Wall Flashing by Carlisle Coatings & Waterproofing Inc.
2. Perm-A-Barrier Wall Flashing by Grace Construction Products.
3. Blueskin SA Air/Vapor Barrier Membrane by Monsey Bakor.
4. Or equal.

2.09 METAL DRIP EDGES

A. Fabricate metal drip edges from 0.0156-in. thick stainless steel.

B. Extend drip edge at least 3-in. into wall and ½-in. out from wall, with a hemmed outer edge bend down 30 degrees.

2.10 MORTAR NET

A. Mortar net shall be high density polyethylene, 90% open plastic mesh with dove tail shape.

2.11 COMPRESSIBLE JOINT FILLER

A. Closed cell neoprene conforming to ASTM D1056, Class RE41.

B. Manufacturers:

1. D/A 2010 Rapid Soft Joint by Duro-O-Wal, Inc.
2. #NS-Closed Cell Neoprene Sponge by Hohmann & Barnard, Inc.
3. 3330 Horizontal Expansion Joint by Masonry Reinforcing Corp. of America.
4. 030 Soft Joint by National Wire Products Industries.
5. Or equal.

2.12 WATER REPELLENCY

A. All split face or smooth face units shall be manufactured using an integral liquid polymeric water-repellent admixture. This admixture shall be introduced into the concrete mix in doses proven to render the units permanently water-repellent.

B. On all exterior walls the use of a matching integral liquid polymeric water-repellent admixture for the mortar shall be used.

PART 3 - EXECUTION

3.01 MORTAR

A. Mortar shall be machine mixed in an approved type of mixer in which the quantity of water can be accurately and uniformly controlled. The mixing time shall not be less than 5 minutes, approximately 2 minutes of which shall be for mixing the dry materials and not less than 3 minutes for continuing the mixing after the water has been added.

B. Where the dry-mix method is employed, the materials for each batch shall be well turned over together until the even color of the mixed, dry materials indicates that the cementitious material has been thoroughly distributed throughout the mass, after which the water shall be gradually added until a thoroughly mixed mortar of the required plasticity is obtained.

C. Mortar boxes shall be cleaned out at the end of each day's work, and all tools shall be kept clean. Mortar that has begun to set shall not be used.

3.02 MASONRY - INSTALLATION

A. No material, which is frozen or covered with frost or snow shall be used in the construction, and no anti freeze salts or ingredients shall be mixed with the mortar. Masonry shall not be laid at temperatures below 40 degrees F, without the approval of the Engineer, and all work shall be done in such a manner as to insure the proper and normal hardening of all mortar. All masonry work shall be so protected and heated that the temperature at the surface will not fall below 50 deg F for a period of 72 hours after placing. Any completed work found to be affected by freezing shall be taken down and rebuilt by the Contractor at his expense.

B. All CMU shall be laid in a full bed of mortar, applied to shells only. Butter the vertical joint of unit already set in the wall and all contact faces of the unit to be set. Each unit shall be placed and shoved against the unit previously laid so as to produce a well compacted vertical mortar joint for the full shell thickness. Units shall set with all cells in a vertical position. The moisture content of the units when laid shall not exceed 35 percent of the total absorption as determined by laboratory test.

C. All masonry units shall be laid in stretcher (running) bond unless otherwise shown. Tool dense and neat.

D. Sizes shall be as specified and called for on the Drawings, and where "Soaps" and "Splits" are used, the space between these members and the backup material shall be slushed full of mortar.

E. Joints of all masonry shall be tooled in accordance with the following:

1. Wait until unit mortar is thumb-print hard before tooling joint.
2. The required personnel of the Contractor shall be kept on the job after hours, if necessary, to properly tool joints.
3. Both vertical and horizontal joints shall be maintained uniform in spacing.

4. Joints for CMU shall be 3/8-in.

5. Concurved.

F. Install all frames required to be set in masonry, set masonry tightly against frames, build in all frame anchors.

G. Surfaces shall be brushed as work progresses and maintained as clean as it is practicable. Unfinished work shall be raked back where possible, and toothed only where absolutely necessary. Before leaving fresh or unfinished work, walls shall be fully covered and protected against rain and wind and before continuing work previously laid shall be swept clean. The tops of walls or other unfinished work shall be protected against all damaged by frost or the elements by means of waterproof paper, tarpaulins, boards or other means approved by the Engineer.

The Contractor shall build in all miscellaneous items to be set in masonry for which placement is not specifically provided under separate Divisions, including, lintels, ties, electrical panel boxes, sleeves, vents, grilles, anchors, grounds, and exterior electric conduits and fixtures, and shall cooperate with other trades whose work is to be coordinated with the work under this Section.

H. All anchorage, attachment, and bonding devices shall be set so as to prevent slippage and shall be completely covered with mortar or grout.

I. All ties and reinforcing for masonry shall be furnished and installed by the Contractor.

3.03 VERTICAL REINFORCEMENT

A. Place steel reinforcement bars vertically in all masonry walls as indicated.

B. Locate vertical reinforcement and dowels in first cells of CMU at jambs of all masonry openings and then space horizontally as indicated.

C. Embed dowels 1-ft.-6-in. into reinforced concrete at top and bottom of CMU walls and partitions. Overlap reinforcing 2-ft.-0-in. using 6-ft.-0-in. maximum length bars.

D. Grout cells as specified.

3.04 CUTTING AND JOBBING

A. Leave slots and opening for inserts, wires, conduits, and similar items of construction, open or cut.

B. Provide recesses or openings at junction boxes, or other locations as indicated.

C. Provide openings in exterior walls and interior partitions at duct, conduit, exhaust and other wall penetrations. Bridge above openings using concrete masonry units. Reinforced masonry lintels shall be provided at openings greater than 1-ft.-4-in. Install membrane wall flashing at exterior wall openings.

D. Masonry units to be dried to 35 percent moisture content from prior cutting or grinding before installation of mechanical and electrical services.

3.05 PARTITIONS

A. Partitions shall be continuous from floor to underside of roof deck as indicated. An isolation joint shall be placed in the intersection between partitions and structural members. Continuous sealants shall be provided at all isolation joints as specified in Section 07900.

3.06 BOND BEAMS

A. Bond beams shall be filled with grout and reinforced as indicated.

3.07 COMPRESSIBLE JOINT FILLERS

A. Compressible joint fillers shall be provided as indicated and where directed by the Engineer.

3.08 CAVITY WALL INSULATION

A. Install insulation to cavity wall air/vapor barrier membrane with mastic as recommended by the manufacturer of the insulation at 1 ft. both horizontally and vertically on the inside face. Mastic to be compatible with air/vapor barrier membrane. Fit the courses of insulation between wall ties or horizontal joint reinforcement and other confining obstructions in the cavity. Tightly butt edges of insulation in both directions. Press insulation units firmly into place against the inside wythe

of masonry or against other construction including structural members to form a continuous thermal barrier.

B. Seal joints between insulation units by applying adhesive, mastic or sealant, recommended by the insulation manufacturer, to edges of each unit to form a tight seal as units are shoved into place. Fill the voids in the completed installation with adhesive, mastic or sealant recommended by the insulation manufacturer.

C. Complete installation and concealment of insulation to avoid prolonged exposure of insulation to direct sunlight by covering exposed insulation.

3.09 MEMBRANE FLASHING INSTALLATION AND COORDINATION

A. Self-Adhered, Composite Flexible Membrane Flashing: Prepare masonry surfaces to receive flashings smooth and free of projections. Install flashing to dry surfaces at air and surface temperatures of 25 deg. F. and above in accordance with manufacturer's recommendations at locations indicated.

1. Precut pieces of flashing to easily handled lengths for each location.
2. Remove release paper and position flashing carefully before placing it against the surface.
3. When properly positioned, place against surface by pressing firmly into place by hand roller or a blunt object. Fully adhere flashing to substrate to prevent water from migrating under flashing.
4. Overlap adjacent pieces 2 inches and roll all seams with a steel hand roller or a blunt object.
5. Install metal drip edges beneath flashing at exterior face of wall. Stop flashing ½-in. back from outside face of wall and adhere flashing to top of metal drip edge.

6. At heads, sills and all flashing terminations, turn up ends a minimum of 2 inches and make careful folds to form an end dam, with the seams sealed.

7. Do not allow the rubberized asphalt surface of the flashing membrane to come in contact with polysulfide sealants, creosote, uncured coal tar products or EPDM.

8. Do not expose flashing membrane to sunlight for more than thirty days prior to enclosure.

B. Accessories:

1. Apply surface conditioner at rate recommended by the manufacturer, prior to flashing installation. Allow surface conditioner to dry completely before flashing application.

2. Apply a bead or trowel coat of mastic along flashing top edge, seams, cuts and penetrations.

3.10 FIELD QUALITY CONTROL

A. Repair joints that are unsound, not full of mortar, or which have hairline cracks due to shrinkage or poor adhesion, as follows:

1. Cut or rake affected mortar to a depth of 3/4 in.

2. Brush out debris.

3. Thoroughly moisten remaining mortar and adjoining masonry and paint with neat cement.

4. Point joint full of mortar.

5. Tool joint to a hard, glassy surface.

6. After first day, wet down walls having repaired joints, at least five times daily, for a minimum of three days.

B. Remove and reconstruct work injured by climatic conditions, or because of insufficient protection as directed by the Engineer and at no additional cost to the Owner.

C. Pointing consists of raking out defective joints, and stack bond pattern joints; repairing defective joints; and working joint after mortar has initially set.

1. Joints except control joints, joints in stack bond pattern and joints to be sealed: Tool concave in a manner which will compact and press the mortar against the units. Strike flush joints covered with plaster, drywall, or waterproofing membrane.

2. Control joints, expansion joints and joints to be sealed shall not contain mortar.

3. Defective joints: Rake out the full depth of the joint, patch with mortar, and tool to match adjacent joints.

D. Apply cleaning agent to sample wall area of 20 sq. ft. in location acceptable to Engineer if cleaning by water does not produce satisfactory results to the Engineer.

1. Do not proceed with cleaning until sample area is acceptable to Engineer.

2. Follow manufacturer's printed instructions.

3. Scrub with approved cleaning agent.

4. Immediately rinse with clear water.

5. Work small sections at a time.

6. Work from top to bottom.

7. Protect sash, metal lintels, and other materials which may corrode when masonry is cleaned with acid solution.

E. When left overnight, cover tops of wythes of masonry walls with a by waterproof membrane extending at least 24 inches down both sides. Protect masonry left for greater length of time in accordance with requirements specified in Section 01500. When work is resumed, clean all top surfaces of loose mortar. Wet units thoroughly, except concrete masonry units when required as specified.

3.11 FIELD TESTING

A. Test concrete masonry units in accordance with ASTM C140.

B. A minimum of two specimens of mortar shall be taken each day. A layer of mortar 1/2 to 5/8 in. thick shall be spread on the masonry units and allowed to stand one minute. The specimens shall then be prepared and tested for compressive strength in accordance with ASTM A 780.

C. Test grout compressive strength in accordance with ASTM C1019. A minimum of two specimens of grout per day shall be sampled and tested. Each specimen shall have a minimum ultimate compressive strength of 2,500 psi at 28 days.

D. Efflorescence Test: Brick which will be exposed to weathering shall be tested for efflorescence. Tests shall be scheduled far enough in advance of starting masonry work to permit retesting if necessary. Sampling and testing shall conform to the applicable provisions of ASTM C 67. Units meeting the definition of "effloresced" will be subjected to rejection.

E. Prism Tests: At least one prism test sample shall be made for each 465 square meters of wall but not less than three such samples shall be made for any building. Three prisms shall be used in each sample. Prisms shall be tested in accordance with ASTM E447.

3.12 CONSTRUCTION TOLERANCES

A. Variation from Plumb: Do not exceed the following construction tolerances in vertical elements, including surfaces of walls, columns, and pilasters:

1. 1/4 inch in 10 feet.

2. 3/8 inch in one story height, or 20 feet, whichever is less, except 1/4 inch for external corners, expansion joints, and other highly conspicuous vertical elements.

3. 1/2 inch in 40 feet or more.

4. Plus or minus 1/4 inch in 10 feet, 1/2 inch maximum, for vertical alignment of head joints.

B. Variation from Level: Do not exceed the following construction tolerances for bed joints and lines of exposed lintels, sills, parapets, horizontal grooves, and other conspicuous horizontal elements:

1. 1/4 inch in one bay or in 10 feet maximum.
2. 1/2 inch in 20 feet or more.

C. Variation from Plan Lines: Do not exceed the following horizontal construction tolerances for related portions of columns, walls, and partitions:

1. 1/2 inch in any bay or in 20 feet maximum.
2. 3/4 inch in 40 feet or more.

D. Variation in Cross Section: Do not exceed the following construction tolerances for thickness of walls and other masonry elements:

1. Minus 1/4 inch.
2. Plus 1/2 inch.

E. Variation in Mortar Joint Thickness: Do not exceed the following construction tolerances for thickness of mortar joints:

1. Bed joints: Plus or minus 1/8 inch.
2. Head joints: Minus 1/4 inch, plus 3/8 inch.

3.13 CLEANING

A. All holes in exposed masonry shall be pointed, and defective joints shall be cut out and repointed with mortar of same color as that of the original and adjoining work.

B. Exposed masonry shall be protected against staining by wall coverings, and excess mortar shall be wiped off the surface as the work progresses.

C. All masonry shall be cleaned with approved detergent solution in accordance with manufacturer's printed directions. No acid or metal scrapers shall be used on masonry.

END OF SECTION 04400

SECTION 04812
GLASS UNIT MASONRY

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Glass masonry units.

B. Mortar bed and pointing mortar.

C. Perimeter treatment.

1.02 RELATED REQUIREMENTS

A. Section 04065 - Mortar and Masonry Grout: Mortar for glass unit masonry.

1.03 REFERENCE STANDARDS

A. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures; American Concrete Institute International.

B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

C. ASTM C270 - Standard Specification for Mortar for Unit Masonry.

D. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

1.04 SUBMITTALS

A. See General Conditions for submittal procedures and requirements.

B. Product Data: Provide data for glass units and accessories.

C. Samples: Submit two glass units and two curved units illustrating color, design, and face pattern.

D. Manufacturer's Installation Instructions: Indicate special procedures, positioning of reinforcement, perimeter conditions requiring special attention.

E. Maintenance Materials: Furnish the following for the Owner's use in maintenance of project.

F. Extra Glass Units: Ten of each type, size, and pattern combination.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of documented experience.

1.06 MOCK-UP

A. Construct one mock-up, 4 feet long by 4 feet high; include glass units with head, jamb, and sill conditions, and perimeter chase and construction.

B. Locate where directed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Accept glass units on site on pallets; inspect for damage.

1.08 FIELD CONDITIONS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530/530.1/ERTA or applicable building code, whichever is more stringent.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Glass Units:

1. Pittsburgh Corning Corporation; Product Decora: www.pittsburghcorning.com, or equal. Pittsburg Corning Corporation Product Decora is the basis of design and is approved for use.
2. Nippon Electric Glass Co. Ltd: www.neg.co.jp/arch.
3. Weck Glass Blocks: www.glashaus.com.

2.02 GLASS UNITS

A. Hollow Glass Units: Unit core filled with white thermal insulation. Permanently seal hollow unit by heat fusing joint; with joint key to assist mortar bond.

1. Provide specially shaped units where indicated, including corners, curved units, and end units.
2. Nominal Size: 4 inch by 8 inch by 8 inch.
3. Color: Clear glass.
4. Pattern and Design: similar to Decora.
5. Insulation Value: U value of.51 BTU/sq ft/h/degree F.
6. Shading Coefficient:.65.
7. Acoustic Sound Loss: 50 decibels.

2.03 ACCESSORIES

A. Panel Reinforcement: Steel, galvanized after fabrication in accordance with requirements of ASTM A123/A123M:

1. Side Rods: Two 9 gage rods spaced 2 inches apart.
2. Cross Rods: 14 gage rods welded 8 inches on center.

B. Expansion Strips: Dense glass fiber matting, 7/16 inches by 4 inches nominal size.

C. Panel Anchors: Steel strips, 20 gage thick x 1 3/4 inch wide; punched with three rows of elongated holes, pattern staggered, hot dip galvanized after fabrication in accordance with requirements of ASTM A123/A123M.

D. Perimeter Channel: Extruded aluminum channel profile, 4-3/4 inch by 1-1/4 inch by 1/8 inch size, one piece per length installed, uncoated finish.

E. Asphalt Emulsion: Water based.

2.04 MORTAR AND POINTING MATERIAL

A. Mortar: ASTM C270, Type M using the Proportion specification as specified in Section 04065.

B. Pointing Mortar: ASTM C270, Type M using the Proportion specification with maximum 2 percent ammonium stearate or calcium stearate per cement weight, with beach sand aggregate.

2.05 MORTAR MIXING

A. Mix mortar ingredients in accordance with Section 04065.

B. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.

C. Do not use anti-freeze compounds to lower the freezing point of mortar.

D. If water is lost by evaporation, re-temper only within two hours of mixing.

E. Use mortar within two hours after mixing at temperatures of 90 degrees F, or two-and-one-half hours at temperatures under 40 degrees F.

2.06 MIX TESTS

A. Testing of Mortar Mix: In accordance with ASTM C780 for compressive strength, consistency, mortar aggregate ratio, water content, air content, and splitting tensile strength.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that openings are ready to receive work.

3.02 PREPARATION

A. Clean glass units of substances that may impair bond with mortar or sealant.

B. Establish and protect lines, levels, and coursing.

C. Protect elements surrounding the work of this section from damage and disfigurement.

3.03 INSTALLATION

A. Erect glass units and accessories in accordance with manufacturer's instructions.

B. Locate and secure perimeter metal channel.

C. Coat sill under units with asphalt emulsion as a bond breaker, and allow to dry.

D. Set panel anchors in mortar bed directly over coating.

E. Provide full mortar joints. Furrowing is not permitted. Remove excess mortar.

F. Maintain uniform joint width of 1/4 inch.

G. Place panel reinforcement at every second horizontal joint in full mortar bed and at first course above and below openings within the glass unit panel.

H. Lap reinforcement joints 6 inches. Discontinue reinforcement at expansion joints.

I. Isolate panel from adjacent construction on sides and top with expansion strips concealed within perimeter trim. Keep expansion joint voids clear of mortar.

J. Shore assembly until setting bed will maintain panel in position without movement.

K. To accommodate pointing mortar, rake out joints 5/8 to 3/4 inch.

L. Fill joints with pointing mortar. Pack into voids. Neatly tool surface to a concave profile.

M. Remove excess mortar.

3.04 TOLERANCES

A. Variation From Joint Width: Plus 1/8 inch and minus 0 inches.

B. Maximum Variation from Plane of Unit to Adjacent Unit: 1/32 inch.

C. Maximum Variation of Panel from Plane: 1/8 inch.

3.05 CLEANING

A. Clean and polish faces of glass unit masonry, using materials and technique that will not scratch or deface units.

3.06 PROTECTION

A. Maintain protective boards at exposed external corners. Provide protection without damaging completed work.

END OF SECTION 04812

SECTION 05120
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

A. The term "Structural Steel" is used as defined in accordance with the AISC Code of Standard Practice.

B. Provide structural steel as indicated and specified.

C. Detailing, fabrication and erection of structural steel shall comply with all applicable OSHA regulations.

1.02 REFERENCES

A. American Institute of Steel Construction AISC:

1. Specification for Structural Steel Buildings
2. AISC Manual of Steel Construction, Allowable Stress Design
3. AISC Code of Standard Practice for Steel Buildings and Bridges
4. AISC Specification for Structural Joints using ASTM A 325 or A 490 Bolts
5. AISC Structural Steel Detailing Manual

B. American Welding Society AWS:

1. AWS D1.1: Structural Welding Code – Steel

C. American Society for Testing and Materials (ASTM) Publications:

1. A 6/A 6M: Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
2. A 36/A 36M: Specification for Carbon Structural Steel
3. A 153/A 153M: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. A 194/A 194M: Specification for Carbon and Alloy-Steel Nuts for Bolts for High-Pressure and High-Temperature Service
5. A 307: Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
6. A 325: Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
7. A 385: Practice for Providing High Quality Zinc Coatings (Hot-Dip)
8. A 449: Specification for Quenched and Tempered Steel Bolts and Studs
9. A 563: Specification for Carbon and Alloy Steel Nuts
10. A 572: Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
11. A 992: Standard Specification for Steel for Structural Shapes for Use in Building Framing

12. F 436: Specification for Hardened Steel Washers

13. F 1554: Standard Specification For Anchor Bolts, Steel, 36, 55, and 105 ksi Yield

D. Occupational Safety and Health Administration (OSHA): Safety and Health Standards for the Construction Industry, 29 CFR 1926 Subpart R Safety Standards for Steel Erection

1.03 SUBMITTALS

A. Shop Drawings: Submit the following in conformance with Section 01300:

1. Shop and erection drawings for all structural steel to be approved by Engineer prior to fabrication.

2. Complete and checked shop and erection drawings for all structural steel components. Show materials, anchor rods, member and connection details, piece marks, openings, shop and field bolting and welding in conformance with AISC Detailing Manual, AISC Manual and AWS Structural Welding Code. Indicate cleaning and shop painting requirements.

3. Submit the welding procedure for each type of weld prior to welding.

4. Qualification test reports bearing witness certification by an independent testing laboratory for each welder, welding operator and tacker to be employed in the work.

B. Mill certificates and copy of reports for all analyses and tests required by referenced ASTM Standard Specifications and AWS Structural Welding Code.

C. Certificate stating that the zinc coating conforms to the ASTM specified requirements.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Section 01400 as specified herein.

B. Tolerances:

1. Maintain tolerances conforming to AISC Code of Standard Practice.

2. Permissible variation tolerances conforming to ASTM A 6.

C. Tension Calibrator:

1. Provide certification by an independent testing laboratory confirming the accuracy of the tension-measuring device when slip-critical connections and connections subject to direct tension are being used. Confirm accuracy not more than 30 days prior to use on Project, and at intervals not more than six months thereafter.

2. Provide tension calibrator measuring device at the job site when high-strength bolts in slip-critical connections and connections subject to direct tension are being installed and tightened.

3. Frequency and of number confirmation tests to be performed and the test procedure to be employed to conform to the AISC Specification for Structural Joints.

4. Return tension calibrator measuring device to the independent testing laboratory for certification if Engineer questions its accuracy.

5. Use the calibrated tension measuring device to tighten high-strength bolts in slip-critical connections and connections subject to direct tension in conform to Table 05120-1.

D. Welding Qualification and Certification:

1. Furnish written welding procedure for all welds in conformance with the AWS D 1.1.
2. Each welder, welding operator and tack welder shall be certified by test to perform type of work required in conformance with AWS D 1.1.
3. If a welder or welding operator has not been engaged in a specific welding process for a period of six months or more, that individual shall be deemed unqualified and shall not perform work on the Project until the individual has been qualified again by testing in conformance with AWS D 1.1.
4. Maintain duplicate qualification and certification records at the job site readily available for examination.

Table 05120-1
Fastener Tension Required for Slip-Critical Connections and Connections Subject to Direct Tension

Nominal Bolt Size		Minimum Tension *			
		A 325 Bolts		A 490 Bolts	
Inches	mm	kips	kN	kips	kN
1/2	13	12	53	15	67
5/8	16	19	84	24	107
3/4	19	28	125	35	156
7/8	22	39	173	49	218
1	25	51	227	64	285
1 1/8	28	56	249	80	356
1 1/4	32	71	316	102	454
1 3/8	35	85	378	121	538
1 1/2	38	103	458	148	658

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide in conformance with Section 01610 and as specified.

B. Transport, handle and store materials to protect from weather, rusting, corrosion or other damage.

C. Store structural shapes off ground on supports, with webs of flanged shapes vertical. Cover and protect steel from snow, rain and ground splatter.

D. Provide carbon steel bolts, nuts and washers for connecting carbon steel members. Ship and store together in wood or metal containers.

PART 2 - PRODUCTS

2.01 STRUCTURAL STEEL

A. W shapes shall conform to ASTM A 992 unless otherwise indicated or specified.

B. C, M, S and HP shapes shall conform to ASTM A 36, Grade 50, unless otherwise indicated or specified.

C. Angles, plates and bars shall conform to ASTM A 36.

D. Round, square and rectangular structural tube members (HSS) shall conform to ASTM A 500, Grade B.

E. Steel pipe shall conform to ASTM A 53, Grade B.

2.02 FASTENERS

A. Carbon Steel Bolts, Nuts and Washers: ASTM A 307, Grade A.

B. High-Strength Carbon Steel Bolts, Nuts and Washers: ASTM A 325, Type 1.

C. Carbon Steel Anchor Rods: ASTM F 1554.

2.03 CRANE RAILS

A. Provide in conformance with crane manufacturer's requirements and as indicated or specified. Provide all materials needed for fabrication and construction of crane rails, including:

1. Joint bar bolts: ASTM A 449 or ASTM A 325.
2. Joint bar nuts: ASTM A 563, Grade B or ASTM A 325.

2.04 WELDING

A. Class E70XX electrodes.

B. Provide equipment for welding, electrodes, welding wire and fluxes capable of producing indicated welds when used by certified welders under AWS welding procedures. Provide welding materials that comply with requirements of AWS Structural Welding Code.

2.05 FABRICATION

A. Fabricate each element and connection as indicated on the fabrication shop drawings approved by the Engineer. Fabricate and shop assemble work to the greatest extent practical in conformance with following publications:

1. AISC Manual
2. AISC Specification for Structural Joints
3. AISC Detailing Manual
4. AWS Structural Welding Code

B. Perform shearing, manual flame cutting with mechanically guided torch and chipping such that it will not induce residual stress in metal being cut. Radii of re-entrant corners shall be as large as practicable but not less than 3/4 inch [19 mm]. Perform flame cutting so that metal being cut is not carrying stress. Finish exposed edges.

C. Provide full cross section bearing on milled ends of columns, crane rails, monorails and bearing stiffeners.

D. Connect all members with ASTM A 325 high strength bolts unless otherwise indicated or specified. Provide clean-cut holes without torn or ragged edges and remove all outside burrs.

E. Welded Connections:

1. Connections indicated or specified shall be welded.
2. Provide complete weather seal weldments made with 1/16-in. [1.6 mm] minimum continuous fillets to all members having Type S and E Service.

F. Weld or bolt shop connections in conformance with specified AWS Structural Welding Code and AISC publications.

G. Make connections with ASTM A 307 carbon steel bolts when indicated or specified.

H. Provide ASTM F 1554 anchor rods with washer and heavy hex nuts. Provide hot-dip galvanized anchor rods, washers and heavy hex nuts with galvanized steel.

I. Provide and fasten bumpers on each end of bridge crane runway beams in conformance with the requirements of the bridge crane manufacturer.

J. Field connections shall be bolted unless welding is indicated.

K. Provide ¾" diameter ASTM A325X high strength bolts for bolted connections. Provide 13/16" diameter holes unless otherwise indicated. Provide one hardened washer under the element turned in tightening. Provide plate washers in both outer plies when oversize or slotted holes are used.

L. Provide F1554 anchor rods for anchorage to concrete and masonry as indicated. Furnish and install one washer and one heavy hex nut with ASTM F 1554 anchor rods unless otherwise indicated.

PART 3 - EXECUTION

3.01 ERECTION

A. Structural steel erection shall comply with 29 CFR 1926 Subpart R

B. Align column bases and bearing plates for beams and similar structural members with steel wedges or shims. Tighten anchor rods after alignment and positioning members and fill entire area under bearing plates with non-shrink, non-metallic grout specified in Section 03300. Remove steel wedges or shims and grout voids solid.

C. Provide anchor rods and anchors with templates for correct placement into concrete, masonry or other supporting materials.

D. Hold steelwork securely in place with temporary bracing and stays to resist all vertical and lateral loads, until members are permanently fastened and floors and roofs completed.

E. Use only calibrated wrenches for tensioning high-strength bolts for slip-critical joints and connections subjected to direct tension.

F. The Owner's testing agency shall inspect and torque test field-assembled bolted construction in conformance with AISC Specification for Structural Joints.

G. Tighten all high-strength bolts to the snug-tight condition in conformance with AISC Specification for Structural Joints, ASTM A325 or A 490 bolts, except when slip-critical joints and connections subjected to direct tension are indicated or specified.

H. High-strength tension control bolting may be substituted for calibrated wrench bolting of slip-critical joints and connections subject to direct tension.

I. Align and adjust members forming parts of a complete assembly before permanent fastening.

J. Fasten splices of compression members and members having milled ends after the abutting surfaces have been brought completely into contact.

K. Report errors in shop fabrication or deformation resulting from handling or transportation immediately to Engineer. Replace and remove from job site incorrect fabricated or deformed material at no additional cost to the Owner.

L. Perform temporary bracing and bolting of work to support construction live load and combined dead, wind, earthquake and erection loads as erection progresses.

M. Do not enlarge holes or damage metal in the vicinity of holes with drift pins during assembly.

N. Enlarge holes to admit bolts for connections only if approved in writing by Engineer. Make enlargements only by drilling. Refinish enlarged holes with paint to match the shop coat.

O. Flame cut bolt holes are not permitted.

P. Where erection bolts are abandoned in place, remove bolts, completely plug weld holes, grind flush with adjacent surfaces and paint to match shop coat.

Q. Align bridge crane runway beams in parallel and level from end to end.

R. Locate monorail beams as indicated and level from end to end.

S. Detail bracing members to avoid eccentric connections.

T. Provide temporary bracing and stays during steel erection to resist vertical and lateral loads until members are permanently fastened and construction is complete.

U. Provide 3/16" x 1" long fillet welds for electrical continuity between members at connections.

V. Provide 1" leveling plates the same size as the base plates for structural steel columns.

3.02 CRANE RAILS

A. Installation: Provide in conformance with crane manufacturer's printed instructions and as indicated or specified.

B. Fasten crane rails to runway beam with rail clamps, in pairs, one each side of rail, spaced not more than 30 inch centers. Bolt each clamp to runway beam top flange with two bolts and self-locking nuts. Allow one/thirty-second inch clearance between clamp plate and top of rail flange and one quarter inch clearance between clamp plate and edge of rail flange to provide a "floating rail" in conformance with AISC Manual. Do not use hook bolts. Center crane rail on the runway beam. In no case shall the crane rail eccentricity be greater than three-fourths of the runway beam web thickness. The entire assembly will be rejected if the crane rail eccentricity exceeds the three-fourths limitation. Replace and remove entire rejected assembly from job site at no additional cost to the Owner.

C. Install crane rails with milled ends and tight joints at splices. Use bolted splice bars to maintain joint alignment in conformance with AISC Manual. Do not use welded butt joints.

D. Retighten splice bolts within 30 days and every three months thereafter in conformance with AISC Manual.

3.03 HIGH-STRENGTH BOLTING

A. Provide workmanship and techniques for bolted construction in conformance with requirements of AISC Specification for Structural Joints and as indicated or specified.

B. Install ASTM A 325 bolts with hardened washer under element being turned in tightening. Install plate washers in both outer plies when using oversize and slotted holes

C. Do not reuse galvanized high-strength bolts, nuts and washers.

3.04 WELDING

A. Workmanship and techniques for welded construction to conform to requirements of AWS Structural Welding Code and as indicated or specified.

B. No field welding permitted unless indicated on Engineer approved fabrication shop drawings.

END OF SECTION 05120

SECTION 05210
STEEL JOISTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide open web steel joists, long span steel joists and steel joist girders as indicated and specified.

B. Provide bridging in accordance with the Steel Joist Institute, OSHA requirements and as indicated and specified.

C. Provide accessories in accordance with Steel Joist Institute requirements.

1.02 REFERENCES

A. Steel Joist Institute (SJI)

1. Standard Specifications for Open Web Steel Joists, K-Series
2. Recommended Code of Standard Practice for Steel Joists and Joist Girders
3. Technical Digest #9 – Handling and Erection of Steel Joists and Joist Girders

B. American Institute of Steel Construction AISC:

1. AISC Manual of Steel Construction, Allowable Stress Design
2. AISC Code of Standard Practice for Steel Buildings and Bridges
3. AISC Specification for Structural Joints using ASTM A 325 or A 490 Bolts
4. AISC Structural Steel Detailing Manual

C. American Society for Testing and Materials (ASTM) Publications:

1. A 307: Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
2. A 325: Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
3. A 384: Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
4. A 385: Practice for Providing High Quality Zinc Coatings (Hot-Dip)
5. A 449: Specification for Quenched and Tempered Steel Bolts and Studs

D. Steel Structures Painting Council (SSPC): Specification 15 Commercial Grade Power Tool Cleaning

E. Occupational Safety and Health Administration (OSHA): Steel Erection Standard 29 CFR 1926.757

1.03 SUBMITTALS

A. Shop Drawings: Submit the following in conformance with the requirements of the General Conditions:

1. Complete and checked shop and erection drawings for all steel joists, joist girders and components.
   a. Indicate standard designations, sizes, spacing and locations of joists, joists, bridging, connections, attachments and top and bottom chord extensions.
   b. Shop and erection drawings for all steel joists shall be approved by Engineer prior to fabrication.

B. Certification, signed and sealed by a Professional Structural Engineer employed by the joist manufacturer and holding current registration in the state in which the joists are to be installed indicating the codes and specifications to which the joist design conforms and stating that all members, elements and connections are designed to withstand the specified loads.

C. Qualification test reports bearing witness certification by an independent testing laboratory for each welder, welding operator and tacker to be employed in the work.

D. Certificate stating that the surface preparation and painting conforms to SSPC-15.

1. Provide shop coatings proposed by type, brand and manufacturer.
2. Provide product data for determining compatibility of shop coatings with field coats.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Section 01400 and as specified.

B. Design joists, girders and connections for the loads, moments and chord forces indicated on the drawings.

C. Design joists, girders and connections for a net uplift of 20 psf [1.0 kPa] unless otherwise indicated on the drawings.

D. Steel joist and joist girder design, manufacture, handling and installation shall conform to the Steel Joist Institute Standard Specifications and load and weight tables.

E. Bridging size and installation shall be as prescribed by the Steel Joist Institute.

F. Steel joists and joist girders shall be fabricated by manufacturer who is a member of Steel Joist Institute.

G. Steel joists and joist girders shall be Steel Joist Institute approved.

H. Welding Qualification and Certification: Each welder, welding operator and tack welder shall be certified by test to perform type of work required in conformance with the Steel Joist Institute.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide in conformance with Section 01610 and as specified.

B. Storage and handling shall conform to the Steel Joist Institute Technical Digest #9.

C. Transport, handle and store materials to protect from weather, rusting, corrosion or other damage.

D. Store joists on substantial timbers and blocking with webs of joists vertical. Cover and protect from snow, rain and ground splatter

E. Deliver, store and handle in a manner that prevents overstressing, deformation or damage.

F. Prevent damage to shop coat.

PART 2 - PRODUCTS

2.01 STEEL JOISTS

A. Fabricate steel joists and joist girders in accordance with the approved shop drawings and the standard specifications of the Steel Joist Institute.

B. Provide top and bottom chord extensions as indicated or required. Top chord extensions shall be Type R.

C. Provide sloped bearing ends where joist or girder slope exceeds ¼" per foot.

D. Provide bearing lengths in accordance with the Steel Joist Institute unless greater bearing lengths are indicated on the drawings.

E. Joist Seats

1. Seats for K-Series joists shall be 2½ inches in depth and shall extend a minimum of 2 ½ inches over steel supports.
2. Fabricate with special seats as indicated or required.

F. Provide additional web members at points of application of concentrated loads to transfer loads to panel points.

2.02 JOIST BRIDGING

A. Provide bridging and bridging anchorage in accordance with the Steel Joist Institute and 29 CFR 1926.757 requirements.

B. Provide cross bridging between the last two joists at the end of a bridging line such as at end walls or expansion joints.

C. Provide a line of bridging near each of the first bottom chord panel points for joists subjected to uplift.

D. Provide bridging to brace the top chord of joists supporting standing seam roofing under gravity loads.

E. Additional bridging shall be provided as required and where indicated on the drawings

F. Manufacturer of joists shall furnish bridging and bridging anchorage.

2.03 CONNECTIONS

A. Provide bolted connections using ASTM A325 bolts.

B. Provide welded connections in conformance with the Steel Joist Institute.

2.04 SHOP PAINTING

A. Provide manufacturer's standard SSPC-15 (gray) shop coat primer.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate placement of anchorages in concrete and masonry construction for securing bearing plates, angles and bridging anchors.

B. Verify that completed construction is ready for and will support steel joist and joist girder placement.

C. Notify the Engineer if discrepancies are found. Do not proceed or install joists and joist girders in areas of discrepancy until those discrepancies have been fully resolved to the satisfaction of the Engineer.

3.02 JOISTS

A. Steel joist erection shall comply with 29 CFR 1926.757.

B. Install in accordance with the Steel Joist Institute specifications, manufacturers printed instruction and as indicated and specified.

C. Install in straight parallel lines at spacing indicated within a tolerance of 1/4-in. plus or minus.

D. Secure by welding to steel support beams or steel plates.

E. Do not apply loads to joists until secured in place and bridging is installed and anchored at its ends.

F. Do not use damaged joists. Replacement joists shall be furnished at Contractors expense.

3.03 BRIDGING

A. Bridging and bridging anchorage shall be provided in accordance with the Steel Joist Institute recommendations and 29 CFR 1926.757 requirements.

3.04 FIELD BOLTED CONNECTIONS

A. Provide bolted connections between joist and columns which are not braced in at least two directions by structural steel members.

3.05 FIELD WELDING

A. Field welding shall be performed in accordance with the American Welding Society, the Steel Joist Institute and the approved shop drawings.

B. Workmanship and techniques for welded construction shall conform to the requirements of the Steel Joist Institute and as indicated or specified.

C. No field welding will be permitted unless indicated on Engineer approved shop drawings.

3.06 SHOP PAINTING

A. Remove looses scale, rust or other foreign materials from fabricated joists, joist girders and accessories.

B. Apply one coat of the manufacturer's standard shop coat.

3.07 FIELD PAINTING

A. Provide field painting in accordance with Section 09900.

END OF SECTION 05210

SECTION 05300
STEEL DECK

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide steel deck and accessories as indicated and specified.

1.02 REFERENCES

A. American Iron and Steel Institute AISI: AISI, Specifications for the Design of Cold-Formed Steel Structural Members

B. Steel Deck Institute:

1. Publication No. 23: Design Manual for Floor Decks and Roof Decks
2. Publication No. 29: Design Manual for Composite Decks, Form Decks, Roof Decks and Cellular Deck Floor Systems with Electrical Distribution

C. American Society for Testing and Materials (ASTM) Publications:

1. ASTM A 611: Standard Specification for Steel, Sheet, Carbon, Cold-Rolled Structural Quality.
2. ASTM A 653/A 653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A 780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

D. American Welding Society AWS: AWS D1.3: Structural Welding Code - Sheet Steel

E. Factory Mutual Engineering Corporation: FM 1-28: Loss Prevention Data

F. American Concrete Institute: ACI 318: Building Code Requirements for Structural Concrete

1.03 DESIGN REQUIREMENTS

A. Design Criteria:

1. Section properties of steel deck shall be calculated in conformance with AISI Specification for the Design of Cold-Formed Steel Structural Members
2. Material and steel deck profiles shall conform to the applicable requirements of the Steel Deck Institute specifications.
3. Steel roof deck shall be capable of supporting all superimposed dead load and the live load indicated on the Drawings with a maximum fiber stress in the deck of 20,000 psi. Superimposed dead loads and all loads to be suspended from the decking shall be accounted for in the design of the deck units.

4. Steel deck shall be anchored to the supporting members to resist an uplift of 45 psf for eave overhangs and 30 psf for all other roof areas.

5. Maximum allowable deflection of roof deck under live load shall not exceed L/240 of the span.

6. Steel deck shall be capable of supporting a construction load of 200 pounds distributed over a one foot width at midspans and at the ends of cantilevers with a maximum fiber stress of 26,000 psi and a maximum deflection of L/240.

7. Steel floor deck shall be capable of supporting the dead load and live load indicated compositely with concrete with a maximum fiber stress in the deck of 20,000 psi. Superimposed dead loads and all loads to be suspended from the decking shall be accounted for in the design of the deck units.

8. Steel floor deck shall be capable of supporting the weight of wet concrete without the need for temporary shoring during concrete placement.

9. Maximum allowable deflection of composite floor deck under live load shall not exceed L/360 of the span.

10. The deck shall be designed to account for construction loads as determined by the Steel Deck Institute construction loading criteria. As a minimum, the steel floor deck shall be capable of supporting the combined weight of the deck, the wet concrete and a 20 psf uniform load or 150 pound concentrated load over a one foot width at midspans and at the ends of cantilevers with a maximum fiber stress of 21,600 psi and a maximum deflection of L/180 or 3/4" relative to the supporting members.

1.04 SUBMITTALS

A. Submit the following in conformance with the requirements of the General Conditions:

1. Shop and erection drawings for all steel deck and accessories shall be approved by the Engineer prior to fabrication. Show support framing, openings, length, type, gage, zinc coating, markings of deck units and accessories, weld size, type, location and sequence.

2. Qualification test reports bearing witness certification by an independent testing laboratory for each welder and welding operator to be employed in the work.

3. Manufacturer's literature indicating steel deck load capacity for various deck styles, gages, spans and depth indicated or specified.

4. Product data for mechanical fasteners to be used.

1.05 QUALITY ASSURANCE

A. Provide in accordance with Section 01400 and as specified.

B. Welding Qualification and Certification:

1. Furnish written welding procedure for all welds in conformance with AWS D 1.3.

2. Each welder, welding operator and tack welder shall be certified by test to perform type of work required in conformance with AWS D 1.3.

3. Maintain duplicate qualification and certification records at the job site readily available for examination.

C. Steel deck shall comply with the specifications and tolerances of the Steel Deck Institute.

D. Roof deck shall comply with tests and approvals as a component for Class 1 roofs in accordance with Factory Mutual FM 1-28.

E. Replace or repair damaged galvanized material as directed by the Engineer at no additional cost to the Owner.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide in conformance with Section 01610 and as specified.

B. Protect steel deck panels from damage at all times.

C. Use care during loading, transportation and unloading to prevent damage and injury to ends, sides and faces of panels.

D. Use nylon slings or padded cables for handling steel deck. Do not drop or drag materials.

E. Store steel deck and accessories off ground on platform or skid supports and protect from snow, rain and ground spatter.

1.07 USE OF DECK DURING ERECTION

A. Do not use steel deck for storage or working platforms until permanently secured in position.

B. Do not allow construction loads to exceed carrying capacity of deck.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide steel deck, ridge plates, valley plates, closures, flashing and sump pans manufactured from galvanized steel sheet conforming to the requirements of ASTM A 653, structural quality, with a minimum yield stress of 33,000 psi.

B. Provide galvanized coating conforming to ASTM A 653 G60.

C. Decking thickness shall be as indicated, but not less than 20 gage 0.034 inches [.86 mm].

D. Ridge plates, valley plates, flat plates at changes in deck direction, closures, accessories and flashings: 18 gage.

E. Sump Pans: Flat, recessed, 14 gage.

F. Welding Washers: 16 gage.

G. Flexible Cell Closures: Rubber, manufacturer's standard.

H. Concrete: 3,000 psi at 28 days conforming to Section 03300, Cast-In-Place Concrete.

2.02 STEEL ROOF DECK

A. Wide Rib (WR) style deck shall conform to the following dimensional requirements:

1. Rib depth shall be a minimum of 1 1/2 inches and spaced at 6 inches on center.
2. Rib width shall be a minimum of 1 3/4 inches at the bottom and a maximum of 2 1/2 inches at the top.

2.03 FABRICATION

A. Fabricate steel deck units in three span lengths or longer, except where one or two span lengths are necessitated due to interruptions at roof or floor openings. Lap ends of units a minimum of 2 inches. Laps shall be made over supports.

B. Bearing flanges of sump pans to overlap steel decking by a minimum of 3 inches. Shape, dimension and reinforce opening in bottom of sump pans to receive roof drains.

PART 3 - EXECUTION

3.01 PREPARATION

A. Check all supporting elements for correct layout and alignment. Correct any deficiencies as required before securing deck units.

B. Remove debris from all surfaces to support steel deck.

3.02 INSTALLATION

A. Install decking and accessories on structural supports in conformance with Steel Deck Institute specifications, the Steel Deck Institute Manual of Construction with Steel Deck, in accordance with placement plans, and as indicated and specified.

B. Place deck panels on steel supports and adjust to final position with ends lapped over structural supports with a minimum end bearing of 1 1/2 inches. Place deck panel from low end upward for decking with a slope greater than 1/4 inch per foot.

C. Permanently fasten deck panels to the structural supports immediately after placement.

D. Cut and fit decking and accessories around openings and other penetrations.

3.03 ATTACHMENT

A. Anchor decking to supporting members with puddle welds or approved mechanical fasteners in accordance with the attachment pattern shown on the placement drawings.

B. Powder actuated or pneumatically driven mechanical fasteners or self drilling screws may be used in lieu of welding only if product data is submitted and approved by the Engineer.

C. Attachment to supports shall conform to the following minimum requirements:

1. Ends and intermediate supports: 3/4 inch diameter puddle welds (or #12 TEK screws as an alternate) at each rib. Penetrate all layers of deck material with weld material at end laps.
2. Weld side laps of adjacent units between supports at intervals not exceeding 12 inches [300 mm] apart with each weld not less than 1 inch long, or as an alternate use #10 TEK screws.

D. Cutting and Fitting:

1. Steel deck erector shall perform all cutting and fitting of units as may be required.
2. Do not make holes that are not indicated on manufacturer's erection shop drawings without prior written approval of Engineer.

E. Accessories:

1. Provide flashing, ridge and valley plates; sump pans and other accessories necessary for a complete and finished installation. Install sump pan at each roof drain.
2. Close open ends of all cell runs with cell closures at columns, openings, walls etc. and ends where cells change direction.
3. Provide and weld flashings into position to close openings between steel deck units and columns, beams and girders.
4. Provide all other closures and flashings required for a complete installation and as recommended by deck manufacturer.
5. Fasten all closures, flashings and sump pans by tack welding at a maximum spacing of 24-in. on center, but not less than one weldment on each corner.
6. Provide special end and side closures at spandrels and openings to act as edging.
7. Provide flexible closures to seal flutes of acoustical deck where it passes over partitions extending to undersides of steel deck.

F. Repair of Zinc Coatings:

1. Clean all weldments by chipping or wire brushing to remove all slag immediately prior to applying galvanize touch-up.
2. Clean with wire brush and prime coat all cut edges with galvanize touch-up as specified herein.
3. Apply galvanize touch-up immediately upon completion of cleaning weldments, abraded and damaged areas. Conform to the following requirements:
4. Galvanize Touch-Up: Where galvanizing is damaged, touch-up abraded areas, using brushed-on method, with zinc-rich coating. Touch-up repair with zinc-rich coating of not less than 3 mil and not more than 6 mil dry film thickness.
5. Repair galvanize using paints containing zinc dust in conformance with ASTM A 780.

6. Materials:
   a. Endupor, zinc-rich coating by Dampney Manufacturing Co., Everett, MA
   b. ZiRP, zinc-rich coating by Duncan Galvanizing Corp., Everett, MA
   c. ZRC Cold Galvanizing Compound or ZRC Galvilite by ZRC Worldwide, Division of Norfolk Corp., Marshfield, MA; or equal.

3.04 CLEANING

A. Remove oil, grease, dirt and debris from deck and leave ready for work of next trade.

END OF SECTION 05300

SECTION 05400
COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes the following:

1. Interior ceiling joist framing.
2. Furring channels

1.02 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide cold-formed metal framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As follows:
   a. Dead Loads: Weights of materials and construction.
   b. Live Loads: 30 psf
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Interior ceiling joist framing: Vertical deflection of 1/240 of the span.
3. Design framing systems to provide for movement of framing members without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).

B. Cold-Formed Steel Framing, General: Design according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions."

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions. In addition, the following specific information shall be provided:

1. Product Data: For type of cold-formed metal framing product and accessory indicated.
2. Shop Drawings: Show layout, spacings, sizes, thicknesses, and types of cold-formed metal framing; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing channels, supplemental framing, bracing, splices, accessories, connection details, and attachment to adjoining work.
   a. For cold-formed metal framing indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Qualification Data: From professional engineer.

C. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the following complies with requirements, based on evaluation of comprehensive tests for current products:

1. Steel sheet.
2. Expansion anchors.
3. Mechanical fasteners.

1.04 QUALITY ASSURANCE

A. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the State of Georgia and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of cold-formed metal framing that are similar to those indicated for this Project in material, design, and extent.

C. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.

D. AISI Specifications and Standards: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" and its "Standard for Cold-Formed Steel Framing - General Provisions."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Store cold-formed metal framing, protect with a waterproof covering, and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide cold-formed metal framing by one of the following:

1. Dale/Incor.
2. Dietrich Metal Framing; a Worthington Industries Company.
3. MarinoWare; a division of Ware Industries.
4. Or equal.

2.02 MATERIALS

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: G90 (Z275) or equivalent.

2.03 CEILING JOIST FRAMING AND FURRING CHANNELS

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with enlarged service holes, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0677 inch .
2. Flange Width: 8-in. minimum.

B. Furring Channel: Provide 20 gage galvanized – channel, 7/8-in.

2.04 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing
3. Anchor clips.
4. End clips.

2.05 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

C. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

2.06 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint:

B. Shims: Load bearing, high-density multimonomer plastic, nonleaching.

C. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.07 FABRICATION

A. Fabricate cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed metal framing members by screw fastening, clinch fastening, as standard with fabricator. Wire tying of framing members is not permitted.
   a. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by not less than three exposed screw threads.
4. Fasten other materials to cold-formed metal framing by screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of finishing materials.
2. Squareness: Fabricate each cold-formed metal framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine supporting substrates and abutting CMV walls for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Install load bearing shims or grout between the underside of wall bottom track or rim track and at joist locations to ensure a uniform bearing surface on supporting masonry construction.

B. Install sealer gaskets to isolate the underside of wall bottom track or rim track and the top of wall at stud or joist locations.

3.03 INSTALLATION, GENERAL

A. Cold-formed metal framing shall be shop fabricated for installation.

B. Install cold-formed metal framing according to AISI's "Standard for Cold-Formed Steel Framing - General Provisions" and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install cold-formed metal framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed metal framing members by screw fastening, or clinch fastening. Wire tying of framing members is not permitted.
   a. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

D. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

E. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

F. Erection Tolerances: Install cold-formed metal framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.04 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches .
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.

C. Space joists not more than 2 inches from abutting walls, and as follows: Joist Spacing: 12 inches.

D. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on Shop Drawings.

1. Install web stiffeners to transfer axial loads of walls above.

E. Install bridging at intervals indicated on Shop Drawings. Fasten bridging at each joist intersection as follows:

1. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

F. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

G. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

3.05 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed metal framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed metal framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05400

SECTION 05500
MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 SCOPE

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install all miscellaneous metals as shown on the Drawings and specified herein. The miscellaneous metal items include but are not limited to the following:

1. Anchors or anchor bolts except those specified to be furnished with all equipment.
2. Bars, rods and channels for grates.
3. Galvanized steel lintels.
4. Embedded angles with welded studs.
5. Miscellaneous steel trim, including the following: Edgings
6. Pipe and tube railings
7. Miscellaneous metal fabrications
8. Shop Coatings
9. Pipe bollards
10. Access Hatches

B. Related Work Specified Elsewhere

1. Section 05120: Structural Steel.
2. Section 05515: Steel Ladders and Platforms
3. Anchor bolts for equipment are included in the respective Sections of Divisions 11, 13, 14 and 15.
4. Pipe hangers, supports and concrete inserts are included under Division 15.
5. Cast iron manholes and fences are included under Division 2.

1.02 SUBMITTALS

A. Manufacturer's data on all materials listed in Part 2 of this Section.

B. Detail drawings, as provided for in the General Conditions, showing sizes of members, method of assembly, anchorage, and connection to other members shall be submitted to the Engineer for review before fabrication.

C. Shop Drawings: For each fabricated item, show the following:

1. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.

2. Plans and elevations.
3. Jointing and connections.
4. Indicate welded connections using standard AWS symbols; indicate net weld length.
5. Profiles of sections and reinforcing.
6. Fasteners and anchors.
7. Accessories.
8. Location of each finish.
9. Provide manufacturer's product data for all access hatches. Shop drawings shall show profiles, accessories, location, and dimensions.
10. Vault access door manufacturer shall provide the manufacturer's Warranty prior to contract close-out.

1.03 QUALITY ASSURANCE

A. Reference Standards: Unless otherwise specified, materials shall conform to the following:

1. Life Safety Code - NFPA 1010.
2. Structural Steel - ASTM A36.
3. Gray Iron Castings - ASTM A48, Class 30.
4. Galvanizing, general - ASTM A123.
5. Galvanizing, hardware - ASTM A153.
6. Galvanizing, assemblies - ASTM A386.
7. Bolts and Nuts - ASTM A307.
8. Stainless Steel Bolts, Bars & Shapes - ASTM A276.
9. Welding Rods for Steel - AWS Spec. for Arc Welding.

1.04 QUALITY CONTROL

A. Contractor shall establish and maintain records sufficient to furnish evidence of quality of materials, equipment and workmanship.

B. Where fabrications are specified to comply with structural performance requirements, provide design certified by a registered professional engineer.

1.05 COORDINATION

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

C. Coordination with Masonry and Concrete Work: Where fabricated items or their anchors are to be embedded into concrete and masonry work, deliver such items to those performing the installation, together with coordination drawings and installation instructions.

1.06 FIELD MEASUREMENTS

A. Field measurements shall be taken at the site to verify or supplement indicated dimensions and to ensure proper fitting of all items.

B. Check actual locations of walls and other construction to which metal fabrications must fit by accurate field measurements before fabrication. Show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabricating products without field measurements. Coordinate construction to ensure that actual dimensions correspond to guaranteed dimensions.

D. Fit fabrications accurately to actual construction. Record field measurements on shop drawings.

1.07 PERFORMANCE REQUIREMENTS

A. Structural Performance Requirements: Where complete sizes or dimensions of structural members, connections, or fasteners of any item are not indicated, design the item to produce strength appropriate to the use intended.

B. Handrails: Design to resist the loads specified by applicable building code(s).

C. Guardrails: Design to resist loads specified by applicable building code(s).

1.08 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 ANCHORS, BOLTS, AND FASTENING DEVICES

A. Anchors, bolts, etc., shall be furnished as necessary for installation of the work of this Section.

B. The bolts used to attach the various members to the anchors shall be the sizes shown or required. Aluminum and stainless steel shall be attached to concrete by means of stainless steel machine bolts and iron or steel shall be attached with steel machine bolts unless otherwise specifically noted.

C. structural purposes, unless otherwise noted, expansion bolts shall be Wej-it "Ankr-Tite", Phillips Drill Co. "Wedge Anchors", or HILTI-HIT(C-100). When length of bolt is not called for on the Drawings, the length of bolt provided shall be sufficient to place the wedge portion of the bolt a minimum of 1-inch behind the reinforcing steel within the concrete.

D. Material shall be as noted on the Drawings. If not listed, 316 stainless steel.

2.02 STEEL ITEMS

A. All miscellaneous lintels and closures not shown on the Drawings shall be galvanized steel and shall be provided as a part of this Section.

1. Provide galvanized loose steel lintels for openings and recesses in masonry walls as shown. Weld adjoining members together to form a single unit. Provide not less than 8-inch bearing at each side of openings unless otherwise indicated.

2. Provide CMU partition support angles as indicated on Drawings. Fabricate from structural steel shapes. Hot-dip galvanize after fabrication.

B. Miscellaneous steel shall be fabricated and installed in accordance with the Drawings and shall include: beams, angles, support brackets, splice plates, anchor bolts (except for equipment furnished in Divisions 11, 13, 14 and 15); lintels and any other miscellaneous steel called for on the Drawings and not otherwise specified.

C. Trench grate shall be as dimensioned on the Drawings.

2.03 ALUMINUM ITEMS

A. Access Doors

1. Access doors shall be provided for vaults as shown on the Drawings. Doors shall be single or double leaf as shown on the Drawings and shall be watertight.

2. Door leaf(s) shall be aluminum diamond pattern plate reinforced to support a minimum live load of 300 psf with a maximum deflection of $1/150^{th}$ of the span. The frame shall be ¼-inch extruded aluminum with an anchor flange around the perimeter.

3. Door leaf(s) shall be equipped with heavy duty hinges, pins, compression spring operators for easy operation and an automatic hold-open arm with release handle. The door leaf(s) shall open to 90 degrees and lock automatically in that position. A snap lock with removable handle shall be provided. All hardware shall be stainless steel. Aluminum finish shall be mill-finish with bituminous coating applied to the exterior of the frame.

4. Provide a 1-1/2 inch drain coupling located in the corner of the channel frame.

5. Fall Protection Grating: Furnish and install on vault access doors, where indicated on plans, fall protection grating system. Panels shall be fiberglass, molded in one piece, with load bearing bars in both directions to allow for use without continuous side support. Grating shall be designed to support a 300 PSF live load. Grating shall be provided with lift assistance for ease of operation.

6. Ladder Extension Post: Furnish and install where indicated on plans ladder safety post. Tubular post shall lock automatically when fully extended. Safety post shall have controlled upward and downward movement. Release lever shall disengage the post to allow it to be returned to its lowered position. Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14" on center and clamp brackets to accommodate ladder rungs up to 1-3/4" in diameter. The post shall be manufactured of high strength square tubing. A pull up loop shall be provided at the upper end of the post to facilitate raising the post.

7. Manufacturer shall be The Bilco Company or Equal.

2.04 PAINT

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal and corrosive atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint20.

C. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint12, except containing no asbestos fibers.

PART 3 - EXECUTION

3.01 FABRICATION - GENERAL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability.

B. Connections and accessories shall be of sufficient strength to safely withstand stresses and strains to which they will be subjected. Steel accessories and connections to steel or cast iron shall be steel, unless otherwise specified. Threaded connections shall be made so that the threads are concealed by fitting.

C. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. The face of welds shall be dressed flush and smooth. Exposed joints shall be close fitting and jointed where least conspicuous.

D. Welding of parts shall be in accordance with the Standard Code for Arc and Gas Welding in Building Construction of the AWS and shall only be done where shown, specified, or permitted by the Engineer. All welding shall be done only by welders certified as to their ability to perform welding in accordance with the requirements of the AWS Code. Component parts of built-up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

E. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust, and foreign matter. Abrasions in the field shall be touched up with zinc rich paint immediately after erection.

F. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Following all manufacturing operations, all items to be galvanized shall be thoroughly cleaned, pickled, fluxed, and completely immersed in a bath of molten zinc. The resulting coating shall be adherent and shall be the normal coating to be obtained by immersing the items in a bath of molten zinc and

allowing them to remain in the batch until their temperature becomes the same as the bath. Coating shall be not less than 2 oz. per sq. ft. of surface. The galvanized coating shall be chromate treated.

G. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.

H. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.

I. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

J. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

3.02 ROUGH HARDWARE

A. Furnish bent, or otherwise custom-fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 Sections.

B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts that bear on wood structural connections, and furnish steel washers elsewhere.

C. Fabricate and shop-assemble in largest practical sections for delivery to site.

1. Prepare and reinforce fabrications as required to receive applied items.
2. Fabricate items with joints tightly fitted and secured.
3. Make exposed joints tight, flush, and hairline.

D. Fasteners: Use concealed fasteners if possible.

1. Exposed Fasteners: Flathead, countersunk type unless otherwise indicated.

E. Anchors: Fabricate to suit conditions indicated; use anchors of same material and finish as item except where specifically indicated otherwise.

F. Welding

1. Welding of steel: Comply with AWS D1.1 recommendations.
2. Provide continuous welds at welded corners and seams.
3. Exposed welds: Grind flush and smooth.

G. Joints Exposed to Weather: Fabricate to keep water out, or provide adequate drainage of water that penetrates.

3.03 FABRICATION - SHEET METAL

A. Comply with general fabrication requirements.

B. Bend sheet metal corners to smallest possible radius.

C. Welding Steel Sheet: Comply with AWS D1.3 recommendations.

3.04 FABRICATION – RAILING

A. Railings - General: Construct as indicated.

1. Preassemble in shop to maximum extent practicable.
2. Bending of members: Use jigs to make each similar configuration the same; make neat bends without other deformation.
3. Close exposed open ends of members using same material as used in member.
4. Expansion joints: Slip joints located not more than 6 inches from posts and at not more than 40 feet on center; provide an internal sleeve at least 4 inches longer than width of joint, fastened to one side of joint.
5. Toeboards: 4 inch by 1/8 inch thick plate; provide for railings around floor openings and at open-sided floors.
6. Provide all components necessary for assembly of railings and for attachment to other work.
   a. For attachment to concrete or masonry: Provide inserts for installation into concrete or masonry, or provide other type of anchorage.
      i) Provide matching metal flange, welded to post, to cover grouted joint.
   b. For anchoring to solid masonry: Use fittings fastened to masonry with bolts and expansion shields unless otherwise indicated.
   c. For anchoring to hollow masonry: Use fittings fastened to masonry with toggle bolts unless otherwise indicated.
   d. Fasten fittings to railings in same manner as railing connections.
7. Exterior railings: Provide weep holes or other means for evacuation of water trapped in hollow members.
8. Wall mounted handrails: Return railing to wall at ends except where otherwise indicated.

B. Steel Pipe/Tube Railings

1. Black steel pipe, Schedule 40, standard weight.
2. Hot-dip galvanize all exterior steel pipe/tube railings; shop prime remainder.
3. Connections: Welded and ground.
4. Welding: Fill joints completely and grind off flush.
5. Elbows: Bends, only.
6. Tee and cross intersections: Coped and welded.

7. Exposed ends: Close with prefabricated fittings or with 3/16-inch-thick steel plate fully welded.

C. Removable Railing Sections: Provide sockets to receive posts; provide removable tamperproof socket covers.

3.05 FABRICATION - GRATINGS

A. Gratings - General: Provide toeboards at open sides of elevated gratings when curb is not otherwise indicated.

3.06 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from structural steel shapes, plates, and bars of profiles shown with continuously welded joints, and smooth exposed edges. Miter corners and use concealed field splices wherever possible.

B. Provide cutouts, fittings, and anchorages as required to coordinate assembly and installation with other work. Provide anchors, welded to trim, for embedding in concrete or masonry construction, spaced not more than 6 inches (150 mm) from each end, 6 inches (150 mm) from corners, and 24 inches (600 mm) o.c., unless otherwise indicated.

C. Galvanize miscellaneous steel trim in the following locations:

1. Exterior locations.
2. All interior locations unless otherwise indicated.

3.07 CAST NOSINGS, TREADS, AND THRESHOLDS

A. Fabricate units of material, sizes, and configurations indicated. If not indicated, provide cast-iron units with an integral abrasive finish. Furnish in lengths as required to accurately fit each opening or conditions.

B. Cast units with an integral abrasive grit consisting of aluminum oxide, silicon carbide, or a combination of both.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Safety Tread Co., Inc.
2. Amstep Products.
3. Armstrong Products, Inc.
4. Balco/Metalines, Inc.
5. Safe-T-Metal Co.
6. Wooster Products Inc.

D. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with the manufacturer.

E. Drill for mechanical anchors with countersunk holes located not more than 4 inches (100 mm) from ends and not more than 12 inches (300mm) o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by the manufacturer.

F. Provide 2 rows of holes for units over 5 inches (125 mm) wide, with 2 holes aligned at ends and intermediate holes staggered.

G. Apply black asphaltic coating to concealed bottoms, sides, and edges of cast-iron units set into concrete.

H. Provide a plain surface texture, except where fluted or cross-hatched surfaces are indicated.

3.08 PIPE BOLLARDS

A. Fabricate pipe bollards from Schedule 80 steel pipe.

1. Cap bollard as detailed on Drawings.

3.09 FABRICATION - SHOP COATINGS

A. Hot-dip galvanize steel and iron assemblies set in concrete and masonry.

B. Shop prime all iron and steel fabrications, except:

1. Fabrications embedded in concrete or mortar.

C. Prepare surfaces to be coated as follows:

1. Solvent-clean in accordance with SSPC-SP 1.
2. Exterior fabrications: Clean in accordance with SSPC-SP 5, SSPC-SP 6, SSPC-SP 8, or SSPC-SP 10.
3. Interior fabrications: Clean in accordance with SSPC-SP 3, SSPC-SP 5, SSPC-SP 6, SSPC-SP 8, or SSPC-SP 10.

D. Shop Priming: Comply with SSPC-PA 1.

1. Apply primer immediately following surface preparation.
2. Do not prime surfaces to be welded.
3. Do not prime surfaces in direct contact bond with concrete.
4. Apply extra coat to corners, welds, edges, and fasteners.

E. Shop Painting: Comply with SSPC-PA 1.

3.10 INSTALLATION

A. Install all items furnished except items to be imbedded in concrete, which shall be installed under Division 3. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown and in accordance with manufacturer's instructions

and approved shop drawings. All dimensions shall be verified at the site before fabrication is started.

B. All steel surfaces to come in contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.

C. Install manufactured components in accordance with manufacturer's instructions.

3.11 PREPARATION

A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

B. Center nosings on tread widths with noses flush with riser faces and tread surfaces.

C. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.12 INSTALLATION, GENERAL

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

E. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.13 INSTALLATION - RAILINGS

A. Cut cored holes for posts.

B. Align joints before anchoring railing.

C. Verify that posts are plumb before anchoring.

D. Set posts with grout.

3.14 CLEANING AND TOUCH-UP

A. Touch up damage to galvanized surfaces using galvanizing repair paint in accordance with ASTM A 780.

B. Touch up shop paint immediately after erection.

1. Clean field welds, bolted joints, and areas where primer is damaged.
2. Paint with material used for shop painting, minimum 2 mils dry film thickness.

END OF SECTION 05500

SECTION 05515
STEEL LADDERS AND PLATFORMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide, erect, set and fasten steel ladders and platforms as shown on the Drawings and as specified herein.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC): Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

B. American Welding Society (AWS): D1.1: Structural Welding Code - Steel.

C. American Society for Testing and Materials (ASTM) Publications:

1. A 6/A 6M: Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
2. A 36/A 36M: Specification for Carbon Structural Steel
3. A 47: Specification for Ferritic Malleable Iron Castings.
4. A 48: Specification for Gray Iron Castings.
5. A 123: Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
6. A 143: Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement.
7. A 153/A 153M: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
8. A 269: Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
9. A 276: Specification for Stainless Steel Bars and Shapes.
10. A 307: Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
11. A 312: Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
12. A 325: Specification for High Strength bolts for Structural Steel Joints.
13. A 366: Specification for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
14. A 384: Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
15. A 385: Practice for Providing High Quality Zinc Coatings (Hot-Dip)
16. F 436: Specification for Hardened Steel Washers
17. A 500: Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
18. A 501: Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

19. A 563: Specification for Carbon and Alloy Steel Nuts
20. A 569: Specification for Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.
21. A 780: Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

1.03 DESIGN CRITERIA

A. Ladders shall be designed to withstand a minimum uniform live load of 100 psf or a concentrated live load of 300 pounds applied on an area of 4 square inches at any point along the element.

B. Platforms shall be designed for a minimum uniform live load of 100 psf or a concentrated live load of 300 pounds applied on an area of 4 square inches at any point along the element.

C. Ladders shall be designed to withstand a minimum of two loads of 250 pounds each, concentrated between any two consecutive attachments. The number and spacing of additional loads shall be in accordance with the anticipated usage of the ladder. Individual steps or rungs shall be designed to support a load of 250 pounds applied at any point.

1.04 SUBMITTALS

A. Shop Drawings: Submit in accordance with the requirements of the General Conditions of the Contract Documents:

1. Manufacturer's specifications, load tables, anchor details and installation details.
2. Shop drawings showing materials, sizes, finishes, locations, attached hardware and fittings, and details for grating and frames.
3. Setting diagrams, erection plans, templates including field erection details showing cuts, copes, connections, holes, threaded fasteners and welds. Indicate welds, both shop and field, by symbols conforming to AWS standards.

B. Certificate stating that the zinc coating conforms to the ASTM specified requirements.

1.05 QUALITY ASSURANCE

A. Provide in accordance with Section 01400 and as specified.

B. Obtain field measurements prior to preparation of shop drawings and fabrication.

C. Welding Qualification and Certification:

1. Furnish written welding procedure for all welds in conformance with AWS Structural Welding Code.
2. Each welder, tacker and welding operator shall be certified by test within the past six months to perform type of work required in conformance with AWS Structural Welding Code. Testing shall be conducted, and witnessed by an independent testing laboratory.
3. Maintain duplicate qualification and certification records at the job site readily available for examination.

D. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

E. Galvanize:

1. Reject all galvanized material, including bolt assemblies, not conforming to specifications.
2. Reject all galvanized material arriving at the site damaged or damaged during construction.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Section 01610 and Section 01611 and as specified.

B. Identify and match-mark, materials, items and fabrications, for installation and field assembly.

C. Deliver items to jobsite as complete units, wherever practicable, ready for installation or erection, with anchors, hangers, fasteners and miscellaneous metal items required for installation.

D. Carefully handle and store materials, protected from weather, rusting and other damage.

E. Store off the ground on suitable supports.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel plates, shapes, pipe and castings shall conform to the following ASTM specifications:

1. Structural steel shapes, bars and plates: ASTM A 36.
2. Steel Pipe: ASTM A 53.
3. Cold-rolled or hot-rolled carbon steel sheets: ASTM A 366 or ASTM A 569.
4. Structural tubing: ASTM A 500 or ASTM A 501.
5. Castings: ASTM A 47 (Grade 32510) or ASTM A 48 (Class 30).
6. Nuts, bolts and washers: ASTM A 325.

B. Stainless Steel:

1. AISI Type 316 unless otherwise indicated or specified. AISI Type (or Grade) 316L for welding.
2. Shapes and Bars: ASTM A 276.
3. Sheet, strip, plate and flat bar: ASTM A 167.
4. Pipe: ASTM A 312.
5. Tubing: ASTM A 269.

C. Welding:

1. Provide filler materials that appropriate for the alloys and tempers in accordance with the AWS Structural Welding Code.
2. Provide Class E70XX electrodes.

2.02 FABRICATION

A. General:

1. Fabricate true to shape, size and tolerances as indicated and specified.
2. Straighten work bent by shearing or punching.
3. Dress exposed edges and ends of metal smooth, with no sharp edges and with corners slightly rounded.
4. Provide sufficient quantity and size of anchors for the proper fastening of the work.
5. Fabricate details and connection assemblies in accordance with drawings, with projecting corners clipped and filler pieces welded flush.
6. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.
7. Use connections of type and design required by forces to be resisted, and to provide secure fastening.
8. Fit work together in fabrication shop and deliver complete, or in parts, ready to be set in place.

B. Welding:

1. Grind exposed edges of welds to a 1/8 inch minimum radius. Grind burrs, jagged edges and surface defects smooth.
2. Prepare welds and adjacent areas such that there is no undercutting or reverse ridges on the weld bead and no sharp peaks or ridges along the weld bead.
3. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

C. Bolting:

1. Provide galvanized stud bolts, nuts and washers for fastening galvanized steel material.
2. Provide holes required for the connection of adjacent or adjoining work wherever noted on drawings. Locate holes for bolting to supports to a tolerance of + 1/16 inch of exact dimensions indicated.

2.03 STEEL PLATFORMS

A. Provide galvanized steel platforms fabricated from structural steel shapes, grating, plates, pipes and tubes as indicated.

B. Provide galvanized steel rectangular bar grating.

C. Provide galvanized steel riveted grating.

D. Railings and Handrails: Provide galvanized steel pipe railing.

E. Provide platforms fabricated from 1/4 inch thick tread. Provide platform plate with nonskid pattern surface.

2.04 STEEL LADDERS

A. Provide steel ladders fabricated from 1-1/4 inch IPS, Schedule 40, galvanized steel pipe uprights and 3/4 inch solid round galvanized steel rod rungs mortised and welded to uprights.

B. Provide rungs spaced at a maximum of 12 inches apart vertically and projecting 7 inches from face of wall to centerline of rungs.

C. Provide steel grab bars built into wall above hinged floor plate covers. Grab bar construction and material to match the steel rungs.

D. Provide safety cages fabricated from galvanized steel components around ladders where the vertical distance between floors or landings is 20 feet or more.

E. Conform to OSHA Regulation 1910.27 for safety cages.

2.05 RAILINGS AND HANDRAILS

A. Railings and Handrails: Provide steel pipe railing and with flush welded joints ground smooth and secured to stringers as indicated.

2.06 FALL PREVENTION SYSTEM

A. Provide ladders with a rigid fall prevention system manufactured of Type 316 stainless steel construction.

B. System Components:

1. Rigid notched carrier rail (1 5/16 inch stainless steel tubing) with guide channel, alignment guide and connecting strap.
2. Saf-t-lok sleeve and safety locking mechanism; mounting brackets.
3. Safety belt with two side "D" rings for attaching
4. Body strap (nylon w/elk leather wrap) with buckle of stainless steel.

C. Conform to OSHA Regulation 1910.27 for fall prevention system.

2.07 HOT-DIP GALVANIZING

A. Provide hot-dip galvanizing in conformance with ASTM A 123, Grade 100 to all grating and frames.

B. Provide hot-dip galvanizing, in conformance with ASTM A 153, to all bolts, nuts and washers that will be used with galvanized steel.

C. Complete all fabrication and prepare surfaces of steel by removing all weld spatter, flux, residue, burrs and metal surface defects before galvanizing. Clean weldments with power wire brush prior to galvanizing.

D. Provide steel dipped into solution of zinc chloride plus ammonium chloride immediately prior to galvanizing. Do not use galvanizing process utilizing flux blanket overlaying molten zinc.

E. Chromate treat all pieces that will be in contact with or encased in concrete or masonry after galvanizing. One coat of one of the following coal tar epoxy coating systems may be substituted for the chromate treatment:

1. 46H-413 Hi-Build Tneme Tar by Tnemec Co. Inc.
2. Bitumastic 300M by Carboline Co.
3. Targuard by Sherwin Williams Co.
4. Or equal.

F. Tap bolt nuts after hot-dip galvanizing in conformance with ASTM A 563.

G. Inspect galvanized material for compliance with these specifications. Mark the material with a clearly visible stamp indicating the name of the galvanizer, the ASTM number and the weight of zinc coating in ounces per square foot.

2.08 GALVANIZE TOUCH-UP

A. Repair damaged galvanized coating using paints containing zinc dust in conformance with ASTM A 780.

B. Field touch-up all damaged galvanized surfaces after installation with one of the following zinc rich coatings:

1. Endupor, zinc-rich coating by Dampney Manufacturing Co. ZiRP, zinc-rich coating by Duncan Galvanizing Corp.
2. ZRC Cold Galvanizing Compound by ZRC Chemical Products Co., Division of Norfolk Corp.
3. Or equal.

2.09 SHOP PAINTING

A. Primer and Finish Paint: Shop apply a high solids epoxy with the following characteristics to all galvanized ferrous surfaces:

1. Solids by Volume: Minimum 69% (± 2%)
2. Type: Self Priming Polyamidoamine
3. Dry Film Thickness: 4-8 mils [.10-.20 mm] per coat
4. Number of Coats: Two
5. Volatile Organic Compound Limit: 2.79 lbs./gallon maximum
6. Color: To be selected by the Engineer

B. Topcoat: Shop apply an aliphatic acrylic polyurethane coating with the following characteristics over the finish paint coating:

1. Solids by Volume: Minimum 58% (± 2%)
2. Dry Film Thickness: 4 mils [.10 mm]
3. Number of Coats: One
4. Volatile Organic Compound Limit: 3.5 lbs./gallon maximum
5. Color: To be selected by the Engineer
6. Topcoat and finish paint shall be compatible and from the same coating manufacturer.

C. Surface preparation, mixing, application and safety requirements shall be in accordance with the paint manufacturer's printed instructions.

D. Provide additional shop paint coating and topcoat for touch-up of surfaces after installation is completed and accepted.

PART 3 - EXECUTION

3.01 GENERAL

A. Set and secure in place as indicated. Where bolted connections are used, draw together and draw nuts tightly. Use bolts of lengths required so that they do not project more than 1/4-inch beyond face of nut. Do not use washers unless specified. Provide hexagonal head bolts with hexagonal nuts.

B. Locate anchors and anchor bolts and build into connecting work. Insert expansion bolts into drilled holes.

C. Install ladders in accordance with approved shop drawings.

3.02 LADDERS

A. Anchor uprights to wall with angles or bent plates welded to uprights and anchored to wall. Grind smooth all welds.

B. Secure interior ladders to slabs with floor flanges.

C. Provide safety cages or fall prevention system as indicated.

D. Provide galvanized structural steel angles, struts, rod hangers, closure plates, and brackets indicated.

3.03 FALL PREVENTION SYSTEM

A. Install in accordance with manufacturer's printed instructions.

3.04 GALVANIZE TOUCH-UP

A. Touch-up abraded hot-dip galvanized areas by the brush applied method with zinc-rich coatings as specified herein having dry film thickness of not less than 6 mils. Make all repairs to galvanized surfaces in conformance with ASTM A 780.

END OF SECTION 05515

SECTION 06100
ROUGH CARPENTRY

PART 1 - GENERAL

1.01 SCOPE

A. The work specified in this section includes furnishing all labor, materials, equipment, and incidentals necessary and install all items of carpentry work complete as shown on the Drawings and as specified herein including nailers, grounds, and cants.

B. The following list of work items is intended only as a guide to that required, the full scope being determined by the actual job conditions:

1. Rough carpentry and framing, as indicated or required, including grounds, blocking, rough frames, nailing strips and strapping.
2. Rough hardware, anchors and bolts, not specifically included elsewhere.
3. Temporary closures.
4. Installation of doors and frames.

1.02 JOB CONDITIONS

A. Deliver, handle and store lumber and plywood to prevent damage. Stack lumber off the ground in a manner to ensure ventilation and protection from the weather.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM A 153-82(87) - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 1982 (Reapproved 1987).
2. AWPA C20-88 - Structural Lumber-Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 1988.
3. AWPA C27-88 - Plywood-Fire Retardant Treatment by Pressure Processes; American Wood Preservers' Association;
4. AWPA M4-84 - Standard for the Care of Preservative Treated Wood Products; American Wood-Preservers' Association; 1984.
5. AWPB LP-2-88 - American Wood Preservers Bureau Quality Control and Inspection Procedures for Softwood Lumber, Timber and Plywood Pressure Treated with Waterborne Preservatives for Above Ground Use; 1988.
6. National Design Specification for Wood Construction; National Forest Products Association (NFPA); 1986 (1990 Supplement).
7. NBS PS 20-70(86) -- American Softwood Lumber Standard; U.S. Department of Commerce, National Bureau of Standards; 1970 (amended 1986).

8. Grade and Treatment Markings shall appear on lumber with seal and stamp of the inspection agency or bureau having jurisdiction.

1.04 PRODUCT HANDLING

A. Delivery and Storage: Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Stack lumber as well as plywood and other panels; provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar materials.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All lumber shall be of sound stock, delivered dry, and shall be fully protected at all times from injury and dampness. Split, broken, or otherwise damaged pieces will not be allowed in the work.

B. Lumber for Blocking, Grounds and Nailers shall be 545, either No. 2 Southern Pine, or standard grade Douglas fir, with moisture content of not more than 19%.

C. Wood members that will contact masonry or concrete shall be pressure treated with chromated copper arsenate or fluorochrome arsenate phenol. Minimum net retention of solid preservative shall be 0.35 lb per cu ft. All other permanent wood in place shall be pressure treated with any of the following: Celcure, Wolman Salts, Copperized Chromated Zinc Arsenate or Pentachlorophenol dissolved in a volatile mineral spirits solvent and bear an approved A4P1-LP-2 or LP-3 quality mark.

D. All treatment shall be performed in accordance with the requirements of the Standard Specifications of the American Wood Preservers Association for treating wood. Apply a heavy coat of the same preservative used in treating to all surfaces cut after treatment.

E. Nails and spikes, where sizes are not indicated or specified, shall be of suitable size and number to securely fasten and hold members in place.

F. Plywood for project sign shall be A-A EXT-APA grade and 1-inch thick. Posts shall be same as for nailers specified in subparagraph B above.

G. All interior plywood to be fire retardant treated plywood.

H. All plywood shall be pressure-treated in accordance with American Wood Preservers Association Standard AWPA C27, and each piece shall bear an Underwriters Laboratories, Inc. label. Plywood shall be APA RATED SHEATHING EXP 1 or better, marked PS 1. After treatment, plywood shall be dried to an average moisture content of 15 percent (13).

PART 3 - EXECUTION

3.01 INSTALLATION

A. All carpentry shall be accurately cut, fitted, and installed as detailed on the Drawings.

B. Anchors shall be installed, where indicated or required, to anchor carpentry or other items securely to masonry or concrete.

C. Forms for structural concrete work shall be as specified in Section 03100. Provide all other miscellaneous wood form work as may be required for the completion of the work.

D. Temporary wood doors and cloth or transparent plastic covered frames shall be provided for exterior wall openings during winter construction.

E. Provide wood members in lengths as long as practicable.

F. For bolted work bore holes of same diameter as bolts and drive bolts into place with snug fit with washers between bolt head and wood surface. Make tight at time of installation bolts and lag screws and retighten just before being enclosed by other work or at completion of work. Length of bolts shall be length to suit the condition. Embed bolts in concrete and solid masonry where possible and use expansion shields in drilled holes where not possible.

G. Use number and size of nails to achieve rigid connections and prevent splitting. Bore holes at least one drill size smaller than nails to prevent splitting if necessary.

H. Anchor nailers to adjacent construction with bolts 6 inches from ends and at intervals not more than 48 inches o.c. between.

I. Install project sign where directed by the Engineer. Sign shall remain in position for the duration of construction.

J. Install, maintain and remove all staging for all trades required to reach all work.

K. At completion remove all excess materials and all resultant debris from the operations of work of this section. Leave work in neat, clean condition satisfactory for receipt of other related items of work, which are to be installed under other sections.

L. No excess materials or debris shall be burned on site or within the City limits of Atlanta.

M. Discard units of material with defects, which might impair quality of work, and units which are too small to use in fabricating work with minimum joints or optimum joint arrangement.

END OF SECTION 06100

SECTION 07080
ROOF INSULATION

PART 1 - GENERAL

1.01 SCOPE

A. Contractor shall furnish all labor, materials, equipment and incidentals required to provide roof insulation as specified.

B. Coordination: Review installation procedures under other Section and coordinate the installation of items that must be installed with the roof insulation.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's specifications and installation instructions for type of insulation required. Include data substantiating that the materials comply with specified requirements.
2. Weights of all equipment to be used on roof.
3. Copies of written guarantee, as specified.
4. Tapers layout.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Insulation work to be performed by roofing contractor.

B. Design Criteria: The thicknesses shown are for the thermal conductivity, K-value at 75 degrees F, Expanded Polystyrene or foamglas with minimum thickness of 1-1/2 inches, 1.5-pound density.

C. Requirements of Regulatory Agencies: Comply with fire resistance ratings required by governing authorities and the Standard Building Code and comply with the following roof insulation requirements:

D. U.L. requirements for Roof Deck Constructions which are rated "UL Construction No. 1".

E. Factory Mutual requirements for "Class I" construction, for fire hazard and wind resistance.

F. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ASTM C-177, Steady-State Thermal Transmission Properties by Means of the Guarded Hot Plate.
2. ASTM C-355, Water Vapor Transmission of Thick Materials.
3. ASTM C-518, Thermal Conductivity of Materials by Means of Heat Flow Meter.
4. ASTM C-1621, Compressive Properties of Rigid Cellular Plastics.

5. ASTM C-1622, Apparent Density of Rigid Cellular Plastics.
6. Federal Specification, HH-I-526C, Thermal (Mineral Fiber) Insulation Board.
7. Federal Specification, HH-530A, Insulation Board, Thermal (Urethane).
8. FM, Approval Guide.
9. U.L., Building Materials Directory.

1.04 JOB CONDITIONS

A. Environmental Requirements:

1. Do not install insulation when weather conditions are such that the deck is not completely dry, or where there is no assurance that the insulation can be completely covered with the complete roofing system by the end of the day.
2. If the insulation becomes wet after installation, do not proceed with the installation of the roofing membrane until the insulation is completely dry.

B. Protection:

1. Do not overload the building structure with the weight of stored materials or use of equipment.
2. Secure building in water-tight manner each night or over a prolonged period of time.
3. Secure roofing material from wind.

C. Sequencing:

1. Proceed with and complete the Work only when materials, equipment and tradesmen required for the installation of the roofing membrane over the insulation are at the site and are ready to follow with this Work immediately (same day) behind the board-type insulation Work.
2. Do not install any more board-type insulation each day than can be covered with complete roofing system by the end of that working day.

1.05 SUBSTITUTIONS

A. Manufacturer of the primary roofing system shall provide either one of the types of roofing insulation specified for complete product and performance responsibility. Any material used must comply with Manufacturer Warranty requirements.

B. The thickness of the insulation shall not vary from what is specified, except for approved tapers.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

B. Insulation is included in the roof system warranty specified in Section 07400.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. Calcium Chloride: Not permitted.
2. Pregenerated foam or similar admixtures: Not permitted.

B. Expanded Polystyrene Board (EPS).

1. Minimums:
   a. Thermal Conductance (k), ASTM C-518 and minimum 2-inch thickness, and 1.5 pounds per square feet density. Minimum R-5.0 at 75 degrees F mean temperature.
   b. Vapor transmission, ASTM C-355: Highly permeable.
   c. Meet requirements of Federal Specification HH-1-526C.

C. Miscellaneous Materials:

1. Joint Tape: 6-inch wide glass fiber tape.
2. Adhesive for Bonding Insulation: The type recommended by the insulation manufacturer, and complying with fire-resistance requirements.
3. Mastic Sealer: Type recommended by insulation manufacturer for bonding edge joints between units and filling voids, must be compatible with EPDM.
4. All cants, tapers and slope: Are to be accomplished with the same material and in addition to the 1-1/2-inch minimum thickness.
5. Wood Nailers: Are to be pressure treated #2 pine (i.e., Wolmanized or Osmose K-33) no creosote lumber is to be used near EPDM.
6. No petroleum based product or bitumen is to come in contact with the area receiving EPDM.

PART 3 - EXECUTION

3.01 PRODUCT DELIVERY STORAGE AND HANDLING

A. Delivery of Materials: Do not deliver insulation materials to the project site before time of installation.

B. Storage Materials: Do not allow insulation materials to become wet or soiled, or covered with ice or snow.

C. Handling of Materials: Comply with manufacturer's recommendations for handling, storage and protection.

3.02 INSPECTION

A. Contractor and his installer must examine the substrate and the conditions under which the insulation Work is to be performed and notify the Engineer in writing of any unsatisfactory

conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to the Engineer.

3.03 INSTALLATION

A. General:

1. Comply with manufacturer's instructions for the particular conditions of installation in each case. If printed instructions are not available or do not apply to the project conditions, consult the manufacturer's technical representative for specific recommendations before proceeding with the Work.
2. Extend insulation full thickness over entire surface to be insulated, using tapers to slope.
3. Cut and fit board-type insulation tightly around obstructions, and fill voids with insulation. Keep back ¼-inch for all vertical flashings.

B. Laying Board-Type Insulation Units:

1. Set units in adhesive and mechanically fasten in accordance with the requirements of the applicable fire and insurance ratings and roofing membrane manufacturer's recommendations, and applied in accordance with the recommendations of the manufacturer of the insulation, adhesive and completed roofing system.
2. Clean existing areas of any mopped or flooded asphalt that will be recovered with EPDM, and cover existing asphaltic materials with protective sheets compatible with EPDM.
3. Install insulation board with the long joints between boards parallel with incline of deck.

3.04 PERFORMANCE

A. Roof insulation Work shall withstand the uplift forces of wind, as defined by the roofing guarantee. Failures of the insulation Work in bond or anchorage to the substrate, or within the insulation, will be considered failures of materials or workmanship under the Roofing Guarantee.

B. The Contractor is responsible for positive roof drainage. No areas of standing or puddling water will be excepted in the new roof surface. The entire roof surface must drain to the existing roof drains.

3.05 PROTECTION

A. Do not permit construction period traffic over completed insulation Work, except as required for roofing.

B. Protect insulation Work from exposure to moisture, damage and deterioration, primarily by prompt installation of roofing Work to be placed over the insulation.

3.06 INSPECTION AND ACCEPTANCE

A. Insulation which has become wet, damaged or deteriorated, as determined by the Engineer, shall be promptly removed from the job at the Contractor's expense.

END OF SECTION 07080

SECTION 07081
FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 SCOPE

A. Work covered in this section includes furnishing all labor, materials, equipment and incidentals required to provide and install flashing and sheet metal as shown and as specified.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Coordination:

1. Review installation procedures under other section and coordinate the installation of items that must be installed with the roof insulation.

D. Related Work specified elsewhere:

1. Section 04255 - Veneer Masonry Systems.
2. Section 04400 - Masonry.
3. Skylight, Section 08635.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data: Indicate product description, finishes and installation instructions, including interface with adjacent materials and surfaces.
2. Shop drawings:
   a. Indicate material types, sizes, shapes, thicknesses, finishes, fabrication details, joint details, anchors, connections, expansion joints, and relations to adjacent work.
   b. Draw details and profiles to quarter size scale.
   c. Include on detailed shop drawings, locations of sleepers and required fastening strips to secure metal work where sheet metal is applied to other than wood surfaces.
3. Samples, submit as follows:
   a. Special finishes: 8" x 8" samples of manufacturer's standard colors for Engineer's color selection, including a clear coated mill finish sample.
   b. Manufactured expansion joint covers, copings, gravel stops, flashing reglets, and other flashing items: 1'-0" length in style and finish specified.
4. Certificates indicating materials supplied or installed are asbestos free.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all federal and state laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. American Iron and Steel Institute (AISI).
2. American Society for Testing and Materials (ASTM).
3. Copper Development Association, Inc. (CDA).
4. Sheet metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

B. Industry Standards:

1. AISI: Stainless Steel Data Manual, 1968 Edition.
2. CDA: Contemporary Copper in Architecture, 1973 Edition.
3. SMACNA: Architectural Sheet Metal Manual, 4th Edition, October 1987.

C. Pre-installation conference:

1. Prior to beginning work, conference will be held to review work to be accomplished.
2. Particular requirements are specified in Loose Single Ply Membrane section.

1.04 DELIVERY, STORAGE AND HANDLING

A. Acceptance at site: Handle materials to prevent damage to surfaces, edges and ends of sheet metal items. Reject and promptly remove damaged materials from site.

B. Storage and protection: Store materials off ground, under cover. Protect from damage and deterioration.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate requirements of this section with work described under Manufactured Roof section. Use flat stock matching respective roofing for shop fabricated flashings, closures and accessories.

1.06 WARRANTY

A. Warrant sheet metal and flashing work provided under this section shall be free of defects in materials and workmanship.and shall be watertight for 5 years after substantial completion. Warranty shall include that other work and materials damaged by leaks shall be promptly repaired at no cost to the Owner. Warrant flashing and sheet metal work to be free of defects in materials and workmanship; combine warranty with roofing warranty.

B. Warranty shall be in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Galvanized Steel Sheet: ASTM A 526, commercial quality, G90 hot-dip galvanized.

1. Finish: Mill phosphatized (paint-grip).

B. Prefinished Galvanized Steel Sheet: Coil coated, commercial quality steel sheet, ASTM A 526 or ASTM A 527, G90 hot-dip galvanized.

1. Finish: 70 percent "Kynar 500" or "Hylar 5000" resin finish over epoxy primer; minimum system thickness 1.0 mil. Provide manufacturer's standard prime coat on underside.
   a. Color: Selected by J. W. Robinson & Associates, Inc, after contract award, from manufacturer's standard color selection.
2. Provide strippable plastic protective film on prefinished surface.

C. Copper Sheet: ASTM B 370, of temper appropriate for use.

D. Bonded Copper: 3 ounces per square foot bonded on both sides by asphalt to heavy waterproofed, reinforced creped kraft paper.

E. EPDM Flashing: Uncured EPDM sheet; minimum 60-mil thickness; minimum properties as follows:

1. Tensile strength (ASTM D 412): 1305 pounds per square inch.
2. Elongation (ASTM D 412): 300 percent.
3. Tear resistance (ASTM D 412): 150 pounds per inch.
4. Ozone resistance (ASTM D 1149): No cracks after 168-hour exposure to one part per million ozone at 104 degrees F and 20 percent strain.
5. Maximum brittleness temperature (ASTM D 746): Minus 49 degrees F.
6. Resistance to heat aging (ASTM D 573): Minimum properties (ASTM D 412) after aging at 240 degrees F for 672 hours:
   a. Tensile strength: 1205 pounds per square inch.
   b. Elongation: 200 percent.
   c. Tear resistance: 125 pounds per inch.
7. Products: Provide one of the following:
   a. "Sure-Seal Elastoform Flashing"; Carlisle Syntec Systems, or equal.
   b. "SPM Flashing"; Manville Roofing Systems, a Division of Schuller International, Inc.

F. Foam Backing For Flexible Flashings: Closed-cell foam rubber; polyethylene, neoprene, or similar soft, compatible material.

1. General: Follow gauge, thickness, or weight requirements in SMACNA Manual for intended use, but not less than indicated below.

2. Sheet Aluminum at .038" min. allow. Standard Color Kynar.
3. Sheet lead: Minimum 4 lbs. PSF hard type.

G. Soldering Materials:

1. Solder: Meeting ASTM 032-76, alloy grade 50A, 50% pig lead and 50% block tin.
2. Solder flux for:
   a. Stainless steel and copper: Muriatic acid neutralized with zinc.
   b. Lead: Non-corrosive rosin.

H. Fasteners: Same material or compatible with sheet metal being fastened.

1. Nails: Flathead, needlepoint, not less than 12 gauge; sufficient length to penetrate substrate 1" minimum.
2. Expansion shields: Lead sleeves.
3. Screws: Self-tapping type with round heads.
4. Bolts: Furnished complete with nuts and washers.
5. Rivets: Round head, solid shank.
6. Blind clips and cleats: Same gauge as sheet metal.

I. Sealant: As specified in Division 7.

1. Use noncuring type for concealed joints.
2. Use nonsag elastomeric type for exposed.

J. Gutter and Conductor-Head Guards: 20-gage bronze or nonmagnetic stainless steel mesh or fabricated units, with selvaged edges and noncorrosive fasteners. Select materials for compatibility with gutters and downspouts.

2.02 FABRICATION

A. Shop Assembly:

1. General:
   a. Fabricate sheet metal in accord with reviewed shop drawings and industry standards.
   b. Form sheet metal work with clear, sharp and uniform arises. Hem exposed edges.
   c. Fabricate corners with minimum 2'-0" returns each side of return; fully seal joints.
2. Stainless steel, aluminum and copper materials:
   a. Roughen edges of stainless steel with emery cloth before soldering.
   b. Solder sheet metal joints with heavy, well heated coppers. Pre-tie joints not less than 1-1/2" wide. Sweat solder through seam's full width.
   c. Provide 1" minimum soldered joints.
   d. Neutralize remaining acid with ammonia or baking powder solution; rinse with water.
3. Provide linear sheet metal items in 10'-0" sections minimum, except as otherwise noted. Form flashing using single pieces for full width.

4. Form specified sheet metal items in accord with SMACNA details and existing adjacent work; gauge indicated in SMACNA description of particular plate, but no less than .038" thickness.

2.03 SHEET METAL GENERAL FABRICATIONS

A. General: As a minimum, fabricate flashings using materials in the thickness listed for each flashing application.

B. Exposed Flashings - Low Slope Roofs or Waterproofing:

1. Scuppers:

2. Galvanized sheet steel: 24 gage (0.0239 inch).

C. Semi concealed Flashings - Low Slope Roofs or Waterproofing:

1. Counter flashing:
   a. Galvanized sheet steel: 24 gage (0.0239 inch).

D. Concealed Wall Flashings:

1. Masonry through-wall flashing:
   a. Bonded Copper: 3 ounces per square foot bonded on both sides by asphalt to heavy waterproofed, reinforced creped kraft paper.

E. Miscellaneous Flashings:

1. Ledge flashing:
   a. Prefinished galvanized steel sheet: 24 gage (0.0239 inch).

F. Vent Stack Flashing: Fabricate from 2-1/2-lb soft sheet lead.

2.04 PREFORMED REGLET FLASHING SYSTEMS

A. General: Fabricate reglet flashing system from 16-oz. copper sheet formed to provide secure interlocking of separate reglet and counter flashing pieces.

B. Types Required:

1. Surface-mounted type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.

2.05 GUTTERS, DOWNSPOUTS AND CONDUCTOR HEADS

A. Fabricate from same material and finish used for adjacent exposed flashings.

B. Form sheet metal to profile dimensions indicated, free from distortions and defects detrimental to water-tight system.

C. Provide precast concrete splash blocks at downspout discharge.

D. Provide formed metal splash pans fabricated from same type of sheet metal used for downspouts. Locate where downspout discharges onto lower roof.

E. Downspout Supports: Brackets.

F. Back-paint concealed metal surfaces with bituminous coating to a minimum of 15 mils dry film thickness.

G. Shop Finish, Rain Drainage: Provide manufacturer's standard baked-on acrylic shop finish on sheet metal rain drainage units (gutters, downspouts, and similar exposed units); 1.0-mil dry film thickness.

H. Splash Pads: Precast concrete type, of size and profiles indicated; minimum 3000 psi at 28 days, with minimum 5 percent air entrainment.

1. Downspout Boots: Steel.
2. Seal metal joints.

I. Splash Pads: Precast concrete type, of size and profiles indicated; minimum 3000 psi at 28 days, with minimum 5 percent air entrainment.

PART 3 - EXECUTION

3.01 INSPECTION

A. Verification of Conditions:

1. Verify locations of all roof openings and penetrations are in accord with reviewed shop drawings.
2. Examine conditions and substrates under which products of this section are to be installed; submit written notification of unacceptable conditions or substrates.
3. Submit copy of installer's report to the Engineer within 72 hours of report receipt.
4. Proceeding with construction activity of this section:
   a. Prior to correction of unacceptable conditions or substrates are prohibited.
   b. Indicates installer's acceptance of conditions and substrates.

3.02 PREPARATION

A. Deliver the following items to entities performing work, for incorporation into their work:

1. Masonry through-wall flashings: Division 4.

B. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Isolate dissimilar metals by means of a heavy bituminous coating, approved paint coating, adhered polyethylene sheet, or other means approved by the Engineer.

3.03 INSTALLATION

A. Sheet Metal:

1. Install work in accord with reviewed shop drawings and industry standards. Provide sheet metal items true to line, without buckling, creasing, warp or wind in finished surfaces.
2. Coordinate flashing at roof surfaces with roofing work to provide weathertight condition at roof terminations.
3. Perform field joining of lengths specified for shop fabrication, but in lengths no shorter than 10'-0" except at closure pieces.
4. Isolate dissimilar materials to prevent electrolysis. Separate using bituminous paint or roofing felt.
5. Seaming:
   a. Comply with SMACNA Plates #99, #100 and other applicable plates.
   b. Flat-lock seams: Finish not less than 3/4" wide.
   c. Soldered lap seams: Finish not less than 1" wide.
   d. Other lap seams: Overlap not less than 4" unless otherwise indicated.
   e. Seams: Orient properly for direction of water flow.
   f. Flatlock seams with cleats soldered.
   g. Lap seams occurring in members sloping 45" or more, 4" minimum; bed in with butyl sealant.
   h. Perform soldering in same manner indicated in FABRICATION Article.
6. Secure sheet metal items using continuous cleats, clips and blind fasteners as indicated; exposed face fastening is prohibited.
7. Fastening:
   a. Nails: Confine to one edge only of flashing 1'-0" or less in width. Space nails at 4" O.C. Maximum. Provide neoprene washers for nails.
   b. Cleats: Continuous; form to profile of item being secured.
   c. Clips: Minimum 2" wide and continuous; form to profile of item being secured. The clips are continuous and the cap flashing replacement.
8. Form joints in linear sheet metal to allow for 1/2" minimum expansion at 20'-0" OP.C. Maximum and 8'-0" from corners. Provide 1'-0" wide back-up plate at intersections. Form plates to profile of sheet metal items. Apply linear sheet metal items in full bed of butyl or urethane caulk over back-up plate.
9. Gutters and downspouts:
   a. Construct with riveted and soldered joints, lapped 1" minimum in direction of flow, provide 3/4" minimum expansion joints at 60`-0" O.C. maximum. Form expansion joints in accord with SMACNA Manual, Plate #7 for gutters up to 20 gauge; Plate #11, 20 gauge and heavier.
   b. Hang gutters with high points equidistant from downspouts, evenly sloped toward downspouts. Support gutters in accord with SMACNA Manual, Plate #14A.
   c. Secure downspouts to exterior walls at 6'-0" O.C. maximum using straps and expansion type fasteners. Lap downspout joints, 1-1/2" minimum and solder.
   d. Finish gutters, downspouts and hangers; required, copper material to match existing.

3.04 CLEANING AND PROTECTION

A. Remove protective film from prefinished sheet metal immediately after installation.

B. Repair or replace work, which is damaged or defaced, as directed by the Engineer.

1. Refinish marred and abraded areas of prefinished sheet using finish manufacturer's recommended methods and materials. Replace units, which, in the opinion of the Engineer, cannot satisfactorily be refinished in place.

C. Remove from sheet metal surfaces any debris or substances, which will inhibit uniform weathering.

D. Protect sheet metal work as recommended by the installer so that completed work will be clean, secured, and without damage at substantial completion.

END OF SECTION 07081

SECTION 07160
BITUMINOUS DAMPROOFING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Substrate preparation.
2. Bituminous dampproofing.
3. Edge and penetration detailing material.

B. Related Sections:

1. Roofing: Elsewhere in Division 7.
2. Water repellents: Elsewhere in Division 7.
3. Special coatings: Division 9.

1.02 SUBMITTALS

A. Product Data: Technical product information and installation instructions which demonstrate that products comply with project requirements.

1.03 REFERENCES

A. Reference Standards: In addition to requirements shown or specified, comply with applicable provisions of following for design, materials, fabrication, and installation of component parts:

1. NRCA Roofing and Waterproofing Manual, National Roofing Contractors Association - NRCA Waterproofing and Dampproofing Manual.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver dampproofing materials to project site in factory-sealed containers.

B. Store materials in dry, well-ventilated space.

1.05 SITE CONDITIONS

A. Install dampproofing only when site weather conditions are acceptable per manufacturer's recommendations.

B. Ventilation: Provide sufficient ventilation during application and curing of dampproofing to prevent buildup of toxic or flammable fumes.

PART 2 - PRODUCTS

2.01 BITUMINOUS DAMPPROOFING MATERIALS

A. Cold-Applied Asphalt Emulsion Semimastic: Fibrated dampproofing mastic of spraying/brushing (medium) consistency, meeting the requirements of ASTM D 1227, Type II; asbestos free.

1. Emulsion Based Semi-Mastic Dampproofing: Non-asbestos short fiber reinforced emulsion asphaltic compound, ASTM D1 227, Type 2, Class 1 or 2.
   a. Application: Brush or spray.
   b. Thickness: Primer and two coats for 1.6 mm 1/16 inch minimum.
   c. Acceptable Products and Manufacturers:
      i) A-H Semi-Mastic Emulsion, Anti-Hydro, Co. Newark, NJ.
      ii) Emulsified Asphalt Semi-Mastic, Euclid Chemical Co., Cleveland, OH.
      iii) Karnak 220AF, Karnak Chemical Corporation, Clark, NJ.
      iv) Sealmastic Type II, W. R. Meadows, Inc., Elgin, NJ.
      v) Hydrocide 700B, Sonneborn Building Products/ChemRex, Inc. Minneapolis, MN.
      vi) Or equal.

2.02 INSTALLATION ACCESSORIES

A. Reinforcing Fabric: Woven or nonwoven glass fiber, treated with organic binders and coated for compatibility with dampproofing bitumen.

B. Detailing Mastic: Asphalt-based plastic roof cement, trowel consistency, meeting the requirements of ASTM D 4586.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are smooth, sound, clean, and dry, and that elements which will penetrate dampproofing have been completed and are rigidly installed.

3.02 PREPARATION

A. Remove honeycomb, aggregate pockets, fins, ridges, and projecting rough areas.

B. Fill cracks, holes, depressions, and irregularities with latex patching mortar or detailing mastic as recommended by membrane manufacturer.

C. Form fillets (cants) at inside corners and around projecting elements using latex patching mortar or detailing mastic.

3.03 INSTALLATION - GENERAL

A. Comply with dampproofing manufacturer's instructions for handling, preparation, application, and protection of dampproofing materials.

3.04 ABOVE-GRADE DAMPPROOFING

A. Cavity Wall Dampproofing: Damp proof air-space side of inner wythe.

1. Form flashings at outside corners, changes in plane, and penetrations larger than 1/2 inch diameter. Apply coating of dampproofing or detailing mastic, embed layer of fiberglass reinforcing extending at least 12 inches onto dampproofing surface, and topcoat with another layer of damp proofing or detailing mastic.
2. Form 3/8-inch fillet of detailing mastic around penetrations 1/2 inch in diameter or smaller.
3. Apply 2 coats of cold-applied fibrated semimastic asphalt emulsion dampproofing at the rate of 20 square feet per gallon per coat.

3.05 PROTECTION AND CLEANING

A. Take measures required to protect completed dampproofing after installation.

B. Clean spillage and soiling from adjacent surfaces using cleaning agents and procedures recommended by the manufacturer of the surface.

END OF SECTION 07160

SECTION 07190
WATER REPELLENTS

PART 1 - GENERAL

1.01 SCOPE

A. Water repellents applied to exterior masonry surfaces.

B. Pressure washing.

1.02 RELATED REQUIREMENTS

A. Section 04200 - Unit Masonry.

B. Section 07900 - Joint Sealers.

1.03 REFERENCE STANDARDS

A. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings; 2005.

B. ASTM D5095 - Standard Test Method for Determination of the Nonvolatile Content in Silanes, Siloxanes, and Silane-Siloxane Blends Used in Masonry Water Repellent Treatments; 1991 (Reapproved 2007).

C. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association; current edition, www.paintinfo.com.

1.04 SUBMITTALS

A. Product Data: Provide product description.

B. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention; cautionary procedures required during application.

C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

D. Manufacturer's Field Reports: Report whether manufacturer's "best practices" are being followed; if not, state corrective recommendations. Email report to the Architect/Engineer the same day as inspection occurs; mail report on manufacturer's letterhead to the Architect/Engineer within 2 days after inspection.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience.

1.06 MOCK-UP

A. Prepare a representative surface 36 by 36 inch in size using specified materials and preparation and application methods on surfaces identical to those to be coated; approved mock-up constitutes standard for workmanship.

B. For proposed substitutions, prepare side-by-side mock-ups of specified and substitute products.

C. Locate where directed.

D. Mockup may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING

A. Convene a meeting at least one week prior to starting work; require attendance of affected installers; invite the Architect/Engineer and Cobb County .

1.08 FIELD CONDITIONS

A. Protect liquid materials from freezing.

B. Do not apply water repellent when ambient temperature is lower than 50 degrees F or higher than 100 degrees F.

C. Do not apply water repellents when wind velocity is higher than 20 mph.

1.09 EXTRA MATERIALS

A. See Section 01600 - Product Requirements, for additional provisions.

B. Provide two gallons of water repellent.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Silane/Siloxane Water Repellents:

1. Tnemec Company, Inc: www.tnemec.com.
2. BASF Construction Chemicals: www.buildingsystems.basf.com.
3. Textured Coatings of America, Inc: www.texcote.com.

2.02 MATERIALS

A. Exact product to be used will be determined by side-by-side mock-up testing of at least 3 products meeting specified requirements; prepare mock ups as specified above; submit cost breakdown for each product used in mock-up, including both unit and total costs.

B. Water Repellent: Non-glossy, colorless, penetrating, water-vapor-permeable, non-yellowing sealer, that dries invisibly leaving appearance of substrate unchanged.

1. Applications: Vertical surfaces and non-traffic horizontal surfaces.

C. Water Repellent: Silicone resin based; colorless.

1. VOC Content: Less than 800 g/L, when tested in accordance with ASTM D 3690 or D 5095.
2. Solids by Volume: 5 percent, minimum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify joint sealants are installed and cured.

C. Verify surfaces to be coated are dry, clean, and free of efflorescence, oil, or other matter detrimental to application of water repellent.

3.02 PREPARATION

A. Prepare surfaces to be coated as recommended by water repellent manufacturer for best results.

B. Do not start work until masonry mortar substrate is cured a minimum of 60 days.

C. Remove oil and foreign substances with a chemical solvent that will not affect water repellent.

D. Pressure wash surfaces to be coated:

1. Concrete: High pressure wash at 1500 to 4000 psi, at 6 to 12 inches from surface.
2. Firm Masonry (Concrete Masonry Units, Brick, and Dense Stone): High pressure wash at 1500 to 4000 psi, at 6 to 12 inches from surface.

E. Allow surfaces to dry completely to degree recommended by water repellent manufacturer before starting coating work.

3.03 APPLICATION

A. Apply water repellent in accordance with manufacturer's instructions, using procedures and application methods recommended as producing the best results.

B. Apply at rate recommended by manufacturer, continuously over entire surface.

C. Apply two coats, minimum.

D. Remove water repellent from unintended surfaces immediately by a method instructed by water repellent manufacturer.

E. Provide manufacturer's field service representative to inspect preparation and application work continuously during entire application period to ensure that manufacturer's "best practices" for preparation and application are being followed.

3.04 PROTECTION OF ADJACENT WORK

A. Protect adjacent landscaping, property, and vehicles from drips and overspray.

B. Protect adjacent surfaces not intended to receive water repellent.

C. Remove water repellent from unintended surfaces immediately by a method instructed by water repellent manufacturer.

END OF SECTION 07190

SECTION 07210
BUILDING INSULATION

PART 1 - GENERAL

1.01 SCOPE

A. The work specified in this section includes furnishing all labor, materials, equipment, and incidentals necessary to install all building insulation complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Section 03300: Cast-in-Place Concrete.

B. Section 07080: Roof Insulation.

1.03 REFERENCES

A. Standards of the following as referenced:

1. American Society for Testing and Materials (ASTM).
2. Federal Specifications (Fed. Spec.).
3. The Society of the Plastics Industry, Inc. (SPI).
4. Underwriters Laboratories, Inc. (UL).

1.04 DEFINITIONS

A. Terms:

1. Bead board: EPS.
2. EPS: Expanded polystyrene.
3. RCPS: Rigid cellular polystyrene.
4. XEPS: Extruded-expanded polystyrene.

1.05 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data and installation instructions for each type insulation and installation.
2. Certificates indicating materials supplied or installed are asbestos free.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and handling:

1. Store materials under cover, off ground: protect from moisture.

2. Remove wet, damaged, or deteriorated materials.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rigid extruded polystyrene insulation (XEPS):

1. Acceptable products:
   a. Amoco Foam Products, Inc.; Amofoam CM.
   b. Dow Chemical U.S.A.; Styrofoam SM.
   c. UC Industries, Inc.; FormulaR 250 SE.
2. Characteristics:
   a. Material: Extruded, closed cell polystyrene boards; meet ASTM C578-87a, Type IV.
   b. Thickness: 2" OR 1.5" as shown on the drawings and schedules.
   c. Density: 2.0 PCF, minimum.
   d. Compressive strength: 20 minimum, tested in accord with ASTM D1621-73.
   e. Water vapor transmission: Maximum 1.1 perm-in., tested in accord with ASTM E96-80, Procedure B.
   f. Size: 1'-4" by 8'-0" and 2'-0" by 8'-0".
   g. Edges: square.
   h. Mark each board indicating code compliance.
3. Mastic: Specified in Air/Vapor Barrier Membrane section.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Comply with manufacturer's product data for each type installation. Cut insulation around obstructions and protrusions. Remove projections interfering with installation.

B. Thermal insulation installation:

1. General: Comply with manufacturer's installation instructions for conditions encountered.
2. Rigid extruded polystyrene insulation (XEPS): Secure to masonry by embedding in tacky dampproofing material. Install between rows of masonry reinforcement with end joints butted.
3. Rigid perimeter slab insulation (XEPS): Install over vapor retarder; extend 4' -0" minimum inside building; and down to top of footing butt adjacent boards. Install in locations indicated or required by local energy code.

END OF SECTION 07210

SECTION 07216
UNDER SLAB VAPOR RETARDER

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Application of an underslab vapor retarder.

1.02 RELATED SECTIONS

A. Section 03 30 00 - Concrete.

B. Section 07 10 00 – Dampproofing and Waterproofing.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
2. ASTM E154 - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs.
3. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
4. ASTM E1643 - Standard Practice for Installation of Water Vapor Retarders Usedin Contact with Earth or Granular Fill Under Concrete Slabs.
5. ASTM F1249-01 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.

B. American Concrete Institute (ACI)

1. ACI 302.1R-96 Vapor Barrier Component (plastic membrane) is not less than 10 mils thick.

1.04 SUBMITTALS

A. Comply with Section 01 33 00 - Submittal Procedures.

B. Submit manufacturer's product data and application instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Store materials in a clean, dry area in accordance with manufacturer's instructions.

C. Stack membrane on smooth ground or wood platform to eliminate warping.

D. Protect materials during handling and application to prevent damage or contamination.

E. Ensure membrane is stamped with manufacturer's name, product name, and membrane thickness at intervals of no more than 85" (220 cm).

1.06 ENVIRONMENTAL REQUIREMENTS

A. Product not intended for uses subject to abuse or permanent exposure to the elements.

B. Do not apply on frozen ground.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. W. R. MEADOWS, INC., PO Box 338, Hampshire, Illinois 60140-0338. (800) 342-5976. (847) 683-4500. Fax (847) 683-4544. Web Site www.wrmeadows.com.

2.02 MATERIALS

A. Plastic Vapor Retarder

1. Performance-Based Specification: Vapor barrier membrane must meet or exceed all requirements of ASTM E 1745, Classes A, B, & C.
   a. Maximum Permeance ASTM E96: 0.0043 Perms
   b. Water Vapor Transmission Rate ASTM F1249 calibrated to ASTM E96 (water method): 0.0016 grains/ft.2/hr
   c. Tensile Strength ASTM E154, Section 9: 52 Lb. Force/Inch
   d. Puncture Resistance ASTM D1709, Method B: 2,655 Grams
   e. Water Vapor Retarder ASTM E1745: Meets or exceeds Class A, B & C
   f. Thickness of Retarder (plastic) ACI 302.1R-96: Not less than 10 mils

2.03 ACCESSORIES

A. Seam Tape

1. High Density Polyethylene Tape with pressure sensitive adhesive. Minimum width 4".

B. Pipe Boots

1. Construct pipe boots from vapor barrier material and pressure sensitive tape per manufacturer's instructions.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive membrane. Notify architect if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected.

3.02 SURFACE PREPARATION

A. Prepare surfaces in accordance with manufacturer's instructions.

3.03 APPLICATION

A. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643–98.

B. Unroll vapor barrier with the longest dimension parallel with the direction of the pour.

C. Lap vapor barrier over footings and seal to foundation walls.

D. Overlap joints 6" and seal with manufacturer's tape.

E. Seal all penetrations (including pipes) with manufacturer's pipe boot.

F. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.

G. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6", and taping all four sides with tape.

END OF SECTION 07216

SECTION 07280
AIR/VAPOR BARRIER MEMBRANE

PART 1 - GENERAL

1.01 SCOPE

A. Provide air barrier membrane and accessories as indicated and specified.

1.02 RELATED WORK

A. Section 04400: Masonry

B. Section 07900: Caulking and Joint Sealants for joint sealant materials and installation

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM) Publications:

1. ASTM D 412: Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
2. ASTM E 96: Test Methods for Water Vapor Transmission of Materials.
3. ASTM E 283: Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
4. ASTM E 330: Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
5. ASTM E 699: Criteria for Evaluation of Agencies Involved in Testing Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee E-6.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions. In addition, the following specific information shall be provided:

1. Product Data: Submit manufacturer's product data for each material. Include standard details, certified test results, installation instructions, and recommendations for sealing penetrations and perimeter.
2. Samples: Submit two labeled samples of each product, not less than 6 by 12 inches in size.
3. Shop Drawings for Air/Vapor Barrier Membrane Mockup: Submit shop drawings for mockup indicating size of mockup, details of construction, and expansion and control joints. Include relationship with adjacent materials, sequence of installation and materials and methods for sealing penetrations. Address shop drawing review comments prior to construction of mockup. Revise to show changes necessary to mockup.
4. Shop Drawings: Submit shop drawings indicating details of construction, including expansion and control joints. Include relationship with adjacent materials, sequence of

installation and materials and methods for sealing penetrations. Shop drawings shall include details of the following connections, as applicable to the project:

a. Foundation and walls.
b. Walls and windows or doors.
c. Different wall systems.
d. Wall and roof.
e. Wall and roof over unconditioned space.
f. Walls, floor and roof across construction, control and expansion joints.
g. Walls, floors and roof to utility, pipe and duct penetrations.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Each worker who is installing air barriers must be either a Certified Applicator as defined in Paragraph 1.05.B below or an installer who is registered with ABAA.

B. Air/vapor barrier installers must be trained and certified by NECA (National Energy Conservation Association) and PSDI (Professional Skills Development Institute) for energy conservation.

C. Single-Source Responsibility: Obtain air/vapor barrier materials from a single manufacturer.

D. Provide products which comply with all state and local regulations controlling use of volatile organic compounds (VOCs).

E. Mockups of Air Vapor Barrier Membrane Installation: Prior to installation on the building, construct a mockup of a typical exterior wall assembly to indicate relationship of materials with air barrier and quality of workmanship. Mockup shall use actual air barrier membrane and wall materials as indicated in Section 04400. Remove mockup assemblies from site at completion of project. Mockup is subject to acceptance by Engineer, rebuild mockups which are rejected at no additional cost to the Owner.

F. Project Meetings:

1. Pre-Construction Meeting: After completion of mockup shop drawings, but prior to construction of mock-up, convene a meeting with representatives of materials to be incorporated in the mockup and installers of mockup. Agenda shall include sequence and details of construction to ensure continuity of air barrier.

2. Pre-Installation Meeting: Convene a pre-installation meeting a minimum of one week prior to commencing work of this section. Attendees shall include representatives of air barrier manufacturer, exterior wall installers and all other associated trades involved in air/vapor barrier installation including project superintendent. Agenda shall include the following:
   a. Review of submittals.
   b. Review of mock-ups.
   c. Coordination with sequence of installation with adjacent materials.
   d. Schedule for subsequent work covering air barrier.
   e. Procedures for quality assurance.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Section 01610 and 01611.

PART 2 - PRODUCTS

2.01 LIQUID AIR/VAPOR BARRIER MEMBRANE

A. Liquid Air Barrier Membrane: Water-based asphalt emulsion modified with a blend of synthetic rubbers and special additives, compatible with sheet membranes.

B. Transition Materials: To provide an air barrier between the membrane and adjacent materials, provide transition materials consisting of extruded low-modulus silicone sheet and silicone sealant intended to adhere to polyethylene side of membrane and adjacent material. Provide the following materials as recommended by the manufacturer of the air barrier membrane:

1. Cleaning Agent: Toluene.
2. Silicone Sheet: Provide preformed corners.
3. Silicone Sealant.

C. Performance Criteria:

1. Air permeability no greater than 0.004 CFM/Ft2 under pressure differential of 0.3 in. of water.
2. Moisture Control: Maximum permeability no greater than 0.1 perms.

D. Manufacturers: Subject to compliance with requirements, provide one of the following products:

1. Grace Construction Products.
2. Carlisle Coatings & Waterproofing Inc.
3. Or equal.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean substrate surfaces to receive air vapor barrier membrane in accordance with manufacturer's instructions. Apply primer if recommended by manufacturer.

B. Installation:

1. Strictly comply with air barrier membrane manufacturer's printed instructions, reviewed submittals and the following:
   a. Apply materials within manufacturer's requirements for temperature and weather conditions.
   b. Do not apply to wet or frozen substrates.
   c. Do not allow contamination with dust or dirt.
   d. Seal completely at edges, perimeter and penetrations.

2. Protect installed work from damage due to harmful weather exposures, physical abuse, and other causes.
3. Provide temporary protection over air barrier membrane if materials covering air barrier membrane will not be installed within manufacturer's recommended time limit for exposure.
4. Repair damage to air barrier membrane caused by construction activities or subsequent work prior to covering.

END OF SECTION 07280

SECTION 07411
PREFORMED METAL ROOF PANELS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Furnish all labor, materials, tools equipment and services for all preformed roofing as indicated, in accord with provisions of the Contract Documents.

B. Completely coordinate with work of all other trades.

C. Removal of existing metal roofing, flashing, gutters, downspouts, sealants, insulation and accessories complete.

D. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

E. Architectural roofing system of preformed steel panels.

F. Thermal roof insulation.

G. Fastening system.

H. Factory finishing.

I. Accessories and miscellaneous components.

1.02 REFERENCE STANDARDS

A. SMACNA: "Architectural Sheet Metal Manual"

B. ASTM A792/A792M - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

C. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. ASTM E1592 - Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.

F. ASTM E1646 - Standard Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.

G. UL 580 - Standard for Tests for Uplift Resistance of Roof Assemblies.

1.03 SUBMITTALS

A. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Storage and handling requirements and recommendations.
2. Installation methods.
3. Specimen warranty.

B. Shop Drawings: Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayment, and special conditions.

1. Show work to be field-fabricated or field-assembled.
2. Include structural analysis signed and sealed by qualified structural engineer, indicating conformance of roofing system to specified loading conditions.

C. Submit thermal calculations and details of floating clip, flashing attachments, and accessorizes certifying the free movement in response to the expansion/contraction forces resulting from a total temperature differential of 110 degrees F.

D. Selection Samples: For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples: For each roofing system specified, submit samples of minimum size 12 inches square, representing actual roofing metal, thickness, profile, color, and texture.

1. Include typical panel joint in sample.
2. Include typical fastening detail.

F. Warranty: Submit specified manufacturer's warranty and ensure that forms have been completed in Cobb County School District's name and are registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in the manufacture of roofing systems similar to those required for this project, with not less than 5 years of documented experience.

B. Installer Qualifications: Company trained and authorized by roofing system manufacturer.

C. Installer must meet the following minimum standards should be meet:

1. Maintain $250,000 general liability coverage for each loss
2. Maintain sufficient worker's compensation coverage as mandated by law.
3. Have no viable claims pending regarding negligent acts or defective workmanship on previously performed or current projects.
4. Has not filed for protection from creditors under any state or federal insolvency or debtor relief statutes or codes.
5. Project foreman is the person having received specific training in the proper installation of the specified system and will be present to supervise whenever material is being installed.

D. Prior to installation of roofing system, conduct a pre-installation conference at the project site.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.

B. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.06 WARRANTY

A. Finish Warranty: Provide manufacturer's special warranty covering failure of factory-applied exterior finish on metal roof panels and agreeing to repair or replace panels that show evidence of finish degradation, including significant fading, chalking, cracking, or peeling within specified warranty period of 5 year period from date of Substantial Completion.

B. Waterproofing Warranty: Provide manufacturer's warranty for weather tightness of roofing system, including agreement to repair or replace roofing that fails to keep out water within specified warranty period of 10 years from date of Substantial Completion.

C. Special Weather tightness Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace metal panel assemblies that fail to remain weather tight, including leaks, without monetary limitation within [5] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Design is based on LokSeam, manufactured by MBCI, or equal.

B. Acceptable manufacturers are:

1. ATAS International, Inc: www.atas.com.
2. Berridge Manufacturing Company
3. Petersen Aluminum Corporation: www.pac-clad.com.

2.02 STRUCTURAL METAL ROOF PANELS

A. Mechanically-seamed, Concealed Fastener, Metal Roof Panels: Structural metal roof panel consisting of formed metal sheet with vertical ribs at panel edges, installed by lapping and mechanically interlocking edges of adjacent panels, and attaching panels to supports using concealed clips and fasteners in a weather tight installation.

1. Basis of Design: MBCI, LokSeam, <http://www.mbci.com/lokseam.html>
2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50, Coating Class AZ55 (Grade 340, Coating Class AZM165) unpainted Galvalume Plus coating.
   a. Nominal Coated Thickness: 0.022 inch/26 gage.
   b. Panel Surface: Smooth with striations in pan.
   c. Exterior Finish: Exposed Galvalume Plus coating.

d. Panel Width: 16 inches.

e. Panel Seam Height: 1.75 inch.

f. Joint Type: Snap joint-seamed.

2.03 ATTACHMENT SYSTEM

A. Concealed System: Provide manufacturer's standard stainless steel concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

B. All self-tapping/self drilling fasteners, bolts, nuts, self locking rivets and other suitable fasteners shall be designed to withstand specified design loads.

C. Provide fasteners with a factory applied coating in a color to match metal roof system application.

D. Provide neoprene washers under heads of exposed fasteners

2.04 PANEL FINISH

A. Strippable film shall be applied to the top side of the painted coil to protect the finish during fabrication, shipping and field handling. This strippable film must be removed before installation.

B. Siliconized Polyester Coating: Epoxy primer and silicone-modified polyester enamel topcoat with minimum dry film thickness of 0.8 mil; color and gloss as selected from manufacturer's standards.

2.05 ACCESSORIES AND MISCELLANEOUS ITEMS

A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, and similar sheet metal items of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.

1. Downspouts: Open face, rectangular profile.

B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish, closed-cell synthetic rubber, neoprene, or PVC, or combination steel and closed-cell foam.

C. Sealants: As specified in Section 07900.

1. Exposed sealant must cure to rubber-like consistency.
2. Concealed sealant must be non-hardening type.
3. Seam sealant must be factory-applied, non-skinning, non-drying type.

D. Thermal Insulation: Provide flexible blanket, rigid, or semi-rigid type, faced with white, flexible, non-dusting vapor retarder tested for maximum flame-spread rating of 50, per ASTM E84; for installation using spacer blocks.

1. Thickness: As required to meet required thermal resistance.

2.06 FABRICATION

A. Panels: Fabricate panels and accessory items at factory, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.

B. Joints: Factory-install captive gaskets, sealants, or separator strips at panel joints to provide weather tight seals, eliminate metal-to-metal contact, and minimize noise from panel movements.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor to remove existing roofing, flashing, insulation, etc necessary to allow inspection of deck and installation of new roofing panels.

B. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.

C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

D. Inspect roof deck to verify deck is clean and smooth, free of depressions, waves or projections, level to +/- 1/4" in 20', and properly sloped.

3.02 PREPARATION

A. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to assure that the completed roof will be free of leaks.

B. Remove protective film from surface of roof panels immediately prior to installation. Strip film carefully, to avoid damage to prefinished surfaces.

C. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by roof panel manufacturer.

D. Where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.03 INSTALLATION

A. Roofing Contractor to coordinate installation of roof with Owner. Protect existing construction to remain and building contents at all times. Provide temporary roofing if necessary to protect building's contents.

B. Overall: Install roofing system in accordance with approved shop drawings and panel manufacturer's instructions and recommendations, as applicable to specific project conditions. Anchor all components of roofing system securely in place while allowing for thermal and structural movement.

1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.

2. Minimize field cutting of panels. Where field cutting is absolutely required, use methods that will not distort panel profiles. Use of torches for field cutting is absolutely prohibited.

C. Accessories: Install all components required for a complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.

D. Install peal and stick membrane and slip sheet on roof substrate before installing preformed metal roof panels. Secure by methods acceptable to roof panel manufacturer, minimizing use of metal fasteners. Apply from eaves to ridge in shingle fashion, overlapping horizontal joints a minimum of 6 inches and side and end laps a minimum of 18 inches. Offset seams in building paper and seams in roofing felt.

E. Grace Ice & Water Shield underlayment to be used on all applications and on low (less than 1:12) slope or complex roofs per manufacturer's recommendation.

F. Roof Panels: Install panels in strict accordance with manufacturer's instructions, minimizing transverse joints except at junction with penetrations.

1. Provide sealant tape or other approved joint sealer at lapped panel joints.
2. Install sealant or sealant tape, as recommended by panel manufacturer, at end laps and side joints.

G. Insulation: Install insulation between roof covering and supporting members to present a neat appearance. Fold, staple, and tape seams unless otherwise approved by Architect.

1. Follow insulation manufacturer's requirements for installation of product.

H. Do not allow panels or trim to come into contact with dissimilar materials.

3.04 CLEANING

A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.05 PROTECTION

A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.

B. Touch-up, repair, or replace damaged roof panels or accessories before date of Substantial Completion.

END OF SECTION 07411

SECTION 07550
MODIFIED BITUMINOUS MEMBRANE ROOFING

PART 1 - GENERAL

1.01 SCOPE

A. Modified bituminous roofing membrane, conventional application.

B. Insulation, flat and tapered.

C. Deck sheathing.

D. Base flashings.

E. Roofing cant strips, accessories, roofing expansion joints, and walkway pads.

1.02 RELATED REQUIREMENTS

A. Section 07081 - Flashing and Sheet metal.

1.03 REFERENCE STANDARDS

A. ASTM C726 - Standard Specification for Mineral Fiber Roof Insulation Board; 2005e1.

B. ASTM C728 - Standard Specification for Perlite Thermal Insulation Board; 2005 (Reapproved 2010).

C. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2010.

D. ASTM D41 - Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing; 2011.

E. ASTM D312 - Standard Specification for Asphalt Used in Roofing; 2000 (Reapproved 2006).

F. ASTM D1863 - Standard Specification for Mineral Aggregate Used on Built-Up Roofs; 2005.

G. ASTM D2822 - Standard Specification for Asphalt Roof Cement, Asbestos-Containing; 2005.

H. ASTM D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2007.

I. ASTM D4897 - Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing; 2001 (Reapproved 2009).

J. ASTM D6162 - Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements; 2000a (Reapproved 2008).

K. ASTM D6163 - Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements; 2000 (Reapproved 2008).

L. ASTM D6164 - Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements; 2011.

M. ASTM D6298 - Standard Specification for Fiberglass Reinforced Styrene Butadiene Styrene (SBS) Modified Bituminous Sheets with a Factory Applied Metal Surface; 2005.

N. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

O. FM DS 1-28 - Wind Design; Factory Mutual Research Corporation; 2007.

P. NRCA ML104 - The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates.

Q. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Section 01340 - Shop Drawings, Product Data and Samples.

B. Product Data: Provide manufacturer's catalog data for membrane and bitumen materials, base flashing materials.

C. Shop Drawings: Indicate joint or termination detail conditions.

D. Samples of Aggregate: Submit two one lb containers of roofing aggregate.

E. Manufacturer's qualification data.

F. Installer's qualification data.

G. Manufacturer's Installation Instructions: Indicate special procedures.

H. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

I. Manufacturer's Field Reports: Indicate procedures followed.

J. Warranty: Submit manufacturer warranty and ensure forms have been completed and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. SUBMITTALS PRIOR TO CONTRACT AWARD:

1. Letter from the proposed primary roofing manufacturer confirming that the bidder is an acceptable Contractor authorized to install the proposed system.
2. Letter from the primary roofing manufacturer stating that the proposed application will comply with the Manufacturer's requirements in order to qualify the project for the specified guarantee.

B. ACCEPTABLE PRODUCTS: Provide primary roofing products, including each type of sheet, all manufactured in the United States, supplied by a single manufacturer which has been

successfully producing the specified types of primary products for not less than 10 years. Provide secondary or accessory products which are acceptable to the manufacturer of the primary roofing products.

C. PROJECT ACCEPTANCE: Submit a completed manufacturer"s application for roof guarantee form along with shop drawings of the roofs showing all dimensions, penetrations, and details. The form shall contain all the technical information applicable to the project including deck types, roof slopes, base sheet and/or insulation assemblies (with method of attachment, and fastener type), and manufacturer"s membrane assembly proposed for installation. The form shall also contain accurate and complete information requested including proper names, addresses, zip codes and telephone numbers. The project must receive approval, through this process, prior to shipment of materials to the project site.

D. SCOPE OF WORK: The work to be performed under this specification shall include but is not limited to the following: Attend necessary job meetings and furnish competent and full time supervision, experienced roof mechanics, all materials, tools, and equipment necessary to complete, in an acceptable manner, the roof installation in accordance with this specification. Comply with the latest written application instructions of the manufacturer of the primary roofing products. In addition, application practice shall comply with requirements and recommendations contained in the latest edition of the Handbook of Accepted Roofing Knowledge (HARK) as published by the National Roofing Contractor"s Association, amended to include the acceptance of a phased roof system installation.

E. LOCAL REGULATIONS: Conform to regulations of public agencies, including any specific requirements of the city and/or state of jurisdiction.

F. MANUFACTURER REQUIREMENTS: The primary roofing materials manufacturer shall provide direct trained company personnel to attend necessary job meetings, perform periodic inspections as necessary, and conduct a final inspection upon successful completion of the project.

G. RECOMMENDED MAINTENANCE: In addition to the guarantee, furnish to the Owner the manufacturer's printed recommendations for proper maintenance of the specified roof system including inspection frequencies, penetration addition policies, temporary repairs, and leak call procedures.

H. Perform work in accordance with NRCA Roofing and Waterproofing Manual.

1. Maintain one copy on site.

I. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

J. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience and approved by manufacturer.

1.06 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

B. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.

B. Store products in weather protected environment, clear of ground and moisture; ballast materials may be stored outdoors.

1. STORAGE: Store materials out of direct exposure to the elements. Store roll goods on a clean, flat and dry surface. All material stored on the roof overnight shall be stored on pallets. Rolls of roofing must be stored on ends. Store materials on the roof in a manner so as to preclude overloading of deck and building structure. Store materials such as solvents, adhesives and asphalt cutback products away from open flames, sparks or excessive heat. Cover all material using a breathable cover such as a canvas. Polyethylene or other non-breathable plastic coverings are not acceptable.
2. HANDLING: Handle all materials in such a manner as to preclude damage and contamination with moisture or foreign matter. Handle rolled goods to prevent damage to edges or ends.

C. DAMAGED MATERIAL: Any materials that are found to be damaged or stored in any manner other than stated above will be automatically rejected, removed and replaced at the Contractor's expense.

D. Protect foam insulation from direct exposure to sunlight.

1.08 FIELD CONDITIONS

A. Coordinate the work with installation of associated flashings and counterflashings installed by other sections as the work of this section proceeds.

B. REQUIREMENTS PRIOR TO JOB START

1. NOTIFICATION: Give a minimum of 5 days notice to the Owner and manufacturer prior to commencing any work and notify both parties on a daily basis of any change in work schedule.
2. PERMITS: Obtain all permits required by local agencies and pay all fees which may be required for the performance of the work.
3. SAFETY: Familiarize every member of the application crew with all fire and safety regulations recommended by OSHA, NRCA and other industry or local governmental groups.

C. ENVIRONMENTAL REQUIREMENTS

1. PRECIPITATION: Do not apply roofing materials during precipitation or in the event there is a probability of precipitation during application. Take adequate precautions to ensure that materials, applied roofing, and building interiors are protected from possible moisture damage or contamination.

D. PROTECTION REQUIREMENTS

1. MEMBRANE PROTECTION: Provide protection against staining and mechanical damage for newly applied roofing and adjacent surfaces throughout this project.

2. TORCH SAFETY: Designate one person on each crew to perform a daily fire watch. The designated crew member shall watch for fires or smoldering materials on all areas of roof construction Continue the fire watch for one hour after roofing material application has been suspended for the day.

3. LIMITED ACCESS: Prevent access by the public to materials, tools and equipment during the course of the project.

4. DEBRIS REMOVAL: Remove all debris daily from the project site and take to a legal dumping area authorized to receive such materials.

5. SITE CONDITION: Complete, to the owner's satisfaction, all job site clean-up including building interior, exterior and landscaping where affected by the construction.

E. Do not apply roofing membrane when environmental conditions are outside the ranges recommended by manufacturer.

F. Do not apply roofing membrane during unsuitable weather.

G. Do not apply roofing membrane when ambient temperature is below 40 degrees F.

H. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

1.09 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. ROOF MEMBRANE GUARANTEE: Upon successful completion of the project, and after all post installation procedures have been completed, furnish the Owner with the manufacturer"s 20 year labor and materials membrane guarantee. The guarantee shall be a term type, without deductibles or limitations on coverage amount, and shall be issued at no additional cost to the Owner. This guarantee shall not exclude random areas of ponding from coverage.

C. Correct defective Work within a two year period after Date of Substantial Completion.

D. Provide 20 year manufacturer's material and labor warranty to cover failure to prevent penetration of water.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Membrane Materials:

1. Siplast: www.siplast.com.

2. GAF Materials Corporation.

3. Schuller International, Inc.

4. Firestone Building Products.

5. Substitutions: See Section 01600 - Product Requirements.

B. BASE SHEET

1. MODIFIED BASE SHEET: A fiberglass reinforced, Styrene-Butadiene-Styrene (SBS) modified asphalt coated sheet, having an minimum weight of 28 lb./square.
   a. Siplast Parabase or equal.

C. VENTING BASE SHEET: A fiberglass reinforced, asphalt coated sheet, having a minimum 1 1/2 inch perforations with a minimum weight of 24 lb./square.

1. Paravent

D. Insulation:

1. Dow Chemical Co: www.dow.com.

2. Owens Corning Corp: www.owenscorning.com.

3. GAF Materials Corporation.

4. The Celotex Corporation.

5. Johns Manville Roofing Products Division.

6. Schuller Internatrional

7. Substitutions: See Section 01600 - Product Requirements.

2.02 ROOFING ACCESSORIES

A. BITUMINOUS CUTBACK MATERIALS

1. PRIMER: A high flash, quick drying, asphalt solvent blend which meets or exceeds ASTM D 41-85 requirements.
   a. Siplast PA-1125 Asphalt Primer

2. MASTICS: An asphalt cutback mastic, reinforced with non-asbestos fibers, used as a base for setting metal flanges and conforming to ASTM D 4586-86 Type II requirements.
   a. Siplast PA-1021 Plastic Cement

B. CAULKING/SEALANTS: A single component, high performance, elastomeric sealant conforming to ASTM D 232 or ASTM C 920 requirements.. Acceptable types are as follows:

1. Sonolastic NP 1 by Sonneborn Building Products; Minneapolis, MN (612) 835-3434

2. Black Jack No. 1010 by Gibson-Homans; Twinsburg, OH (216) 425-3255

C. CERAMIC GRANULES: No. 11 Grade Specification Ceramic granules of color scheme matching the granule surfacing of the finish ply.

1. Siplast No. 11 Granules

D. WALKTREAD: A prefabricated, puncture resistant polyester core reinforced, polymer modified bitumen sheet material topped with a ceramic-coated granule wearing surface.

1. Thickness: 0.217 in - (5.5 mm)
2. Weight: 1.8 lbs/ft^2 - (8.8 Kg/m^2)
3. Width: 30 in (76.2 cm)
   a. Paratread Roof Protection Material

E. BASE SHEET FASTENERS

2.03 PREPARATION

A. ROOFING - CONVENTIONAL APPLICATION

1. Modified Bituminous Roofing: System to serve as design guideline: GAF System I-3-1 MGPFR, with insulation.
   a. Other Acceptable Products and systems as manufactured by:
      i) The Celotex Corporation.
      ii) GS Roofing Products Company.
      iii) Schuller International, Inc..
      iv) Firestone Buidling Products
2. Roofing Assembly Requirements:
   a. Roof-Ceiling Fire Resistance Rating: Conform to UL Assembly Design No. P732 and D925.
   b. Insulation Thermal Value (R), minimum: 14; provide insulation of thickness required.
3. Acceptable Insulation Types - Constant Thickness Application: Any of the types specified.
   a. Single layer of polyisocyanurate or composite board.
4. Acceptable Insulation Types - Tapered Application: Any of the types specified.
   a. Tapered perlite board.
5. Surfacing: Aggregate where indicated.

B. BITUMINOUS MATERIALS

1. Bitumen: Asphalt, ASTM D312 Type III; for adhering insulation, use Type III.
2. Primer: ASTM D41, asphalt type.
3. Roof Cement: ASTM D4586, Type II.

C. INSULATION

1. Perlite Board Insulation: Expanded perlite mineral aggregate, ASTM C728, with the following characteristics:
   a. Tapered Board: Slope as indicated; minimum thickness 1 inch; fabricate of fewest layers possible.

2. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C1289, Type I, aluminum foil both faces; Class 1, non-reinforced foam core, and with the following characteristics:
   a. Facing: Asphalt felt or mat both faces.
   b. Board Size: 48 x 96 inch.
   c. Board Thickness: 1-1/2 inch.
   d. Board Edges: Square.
3. Composite Board Insulation: Top layer perlite, bottom layer polyisocyanurate, complying with ASTM C1289, and with the following characteristics:
   a. Polyisocyanurate surfaces faced with aluminum foil.
   b. Polyisocyanurate surfaces faced with aluminum foil.

D. ACCESSORIES

1. Prefabricated Roofing Expansion Joint Flashing: As specified elsewhere in Division 07000..
2. Wood Cants: Wood blocking, pressure preservative treated.
3. Sheathing Adhesive: Non-combustible type, for adhering gypsum sheathing to metal deck.
4. Sheathing Joint Tape: Heat resistant type, min. 2 inch wide, self adhering.
5. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches wide; self adhering.
6. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
   a. Length as required for thickness of insulation material and penetration of deck substrate, with metal washers.
7. Roofing Nails: Galvanized, hot dipped type, size and configuration as required to suit application.
8. Strip Reglet Devices: Galvanized steel, maximum possible lengths per location, with attachment flanges.
9. Insulation Perimeter Restraint: Stainless steel edge device configured to restrain insulation boards in position and provide top flashing over ballast.
10. Sealants: As recommended by membrane manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is supported and secure.

C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

D. Verify deck surfaces are dry and free of snow or ice.

E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 METAL DECK PREPARATION

A. Install deck sheathing on metal deck:

1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.
3. Tape joints.
4. Mechanically fasten sheathing to roof deck, in accordance with Factory Mutual recommendations and roofing manufacturer's instructions.
   a. Over entire roof area, fasten sheathing using 6 fasteners with washers per sheathing board.
   b. At roof perimeter to a distance of 4 ft in from edges, fasten sheathing using 6 fasteners with washers per board.

B. Protected Membrane Application: Mop cant strips in place with hot bitumen.

3.03 ROOF MEMBRANE INSTALLATION

A. ROOF MEMBRANE APPLICATION: Apply roofing in accordance with roofing system manufacturer's instructions and the following requirements. Application of roofing membrane base ply shall immediately follow application of base sheet and/or insulation as a continuous operation.

B. AESTHETIC CONSIDERATIONS: An aesthetically pleasing overall appearance of the finished roof application is a standard requirement for this project. Make necessary preparations, utilize recommended application techniques, apply the specified materials (i.e. granules, metallic powder), and exercise care in ensuring that the finished application is acceptable to the Owner.

C. PRIMING: Prime metal flanges and concrete and masonry surfaces with a uniform coating of ASTM D 41 asphalt primer.

D. BITUMEN CONSISTENCY: Cutting or alterations of bitumen, primer, and sealants will not be permitted.

E. ROOF MEMBRANE APPLICATION: Apply all layers of roofing free of wrinkles, creases or fishmouths. Exert sufficient pressure on the roll during application to ensure prevention of air pockets. Stagger the lap seams between the base ply layer and the finish ply layer. Stagger the courses to ensure this.

1. Apply all layers of roofing perpendicular to the slope of the deck.
2. Fully bond the base ply to the prepared substrate, utilizing minimum 3 inch side and end laps. Apply each sheet directly behind the torch applicator. Cut a dog ear angle at the end laps on overlapping selvage edges. Using a clean trowel, apply top pressure to top seal T-laps immediately following sheet application. Stagger end laps a minimum of 3 feet.

3. Fully bond the finish ply to the base ply, utilizing minimum 3 inch side and end laps. Apply each sheet directly behind the torch applicator. Stagger end laps of the finish ply a minimum 3 feet. Cut a dog ear angle at the end laps on overlapping selvage edges. Using a clean trowel, apply top pressure to top seal T-laps immediately following sheet application. Stagger side laps of the finish ply a minimum 12 inches from side laps in the underlying base ply. Stagger end laps of the finish ply a minimum 3 feet from end laps in the underlying base ply.

4. Apply all layers of roofing parallel to the slope of the deck.

5. Fully bond the base ply to the prepared substrate, utilizing minimum 3 inch side and end laps. Apply each sheet directly behind the torch applicator. Cut dog ear angles on underlying end laps at the finish edge and the overlapping selvage edges. Using a clean trowel, apply top pressure to top seal T-laps immediately following sheet application. Stagger end laps a minimum of 3 feet.

6. Fully bond the finish ply to the base ply, utilizing minimum 3 inch side and end laps. Apply each sheet directly behind the torch applicator. Stagger end laps of the finish ply a minimum 3 feet. Cut dog ear angles on underlying end laps at the finish edge and the overlapping selvage edges. Using a clean trowel, apply top pressure to top seal T-laps immediately following sheet application. Stagger side laps of the finish ply a minimum 12 inches from side laps in the underlying base ply. Stagger end laps of the finish ply a minimum 3 feet from end laps in the underlying base ply.

7. Maximum sheet lengths and special fastening of the specified roof membrane system may be required at various slope increments where the roof deck slope exceeds 1/2 inch per foot. The manufacturer shall provide acceptable sheet lengths and the required fastening schedule for all roofing sheet applications to applicable roof slopes.

F. GRANULE EMBEDMENT: Broadcast mineral granules over all bitumen overruns on the finish ply surface, while the bitumen is still hot, to ensure a monolithic surface color.

G. WATER CUT-OFF: At end of day's work, or when precipitation is imminent, construct a water cut-off at all open edges. Cut-offs can be built using asphalt or plastic cement and roofing felts, constructed to withstand protracted periods of service. Cut-offs must be completely removed prior to the resumption of roofing.

3.04 FIELD QUALITY CONTROL AND INSPECTIONS

A. SITE CONDITION: Leave all areas around job site free of debris, roofing materials, equipment and related items after completion of job.

B. NOTIFICATION OF COMPLETION: Notify the manufacturer by means of manufacturer's printed Notification of Completion form of job completion in order to schedule a final inspection date.

C. FINAL INSPECTION - POST-INSTALLATION MEETING: Hold a meeting at the completion of the project, attended by all parties that were present at the pre-job conference. A punch list of items required for completion shall be compiled by the Contractor and the manufacturer's representative. Complete, sign, and mail the punch list form to the manufacturer's headquarters.

D. ISSUANCE OF THE GUARANTEE: Complete all post installation procedures and meet the manufacturer's final endorsement for issuance of the specified guarantee.

3.05 GENERAL INSULATION INSTALLATION

A. Ensure vapor retarder is clean and dry, continuous, and ready for application of roofing system.

B. Attachment of Insulation:

1. Mechanically fasten first layer of insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual requirements.
2. Embed second layer of insulation into flood coat mopping of hot bitumen in accordance with roofing and insulation manufacturers' instructions.

C. Lay subsequent layers of insulation with joints staggered minimum 6 inch from joints of preceding layer.

D. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

E. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.

F. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.

G. Do not apply more insulation than can be covered with membrane in same day.

3.06 GENERAL MEMBRANE APPLICATION

A. Apply membrane in accordance with manufacturer's instructions.

B. Apply membrane; lap and seal edges and ends permanently waterproof.

C. Apply smooth, free from air pockets, wrinkles, fish-mouths, or tears. Ensure full bond of membrane to substrate.

D. At end of day's operation, install waterproof cut-off. Remove cut-off before resuming roofing.

E. At intersections with vertical surfaces:

1. Extend membrane over cant strips and up a minimum of 8 inches onto vertical surfaces.
2. Apply flexible flashing over membrane.
3. Secure flashing to nailing strips at 4 inches on center.
4. Insert base flashing into reglets and secure.

F. Around roof penetrations, mop in and seal flanges and flashings with flexible flashing.

G. Install roofing expansion joints where indicated. Make joints watertight.

1. Install prefabricated joint components in accordance with manufacturer's instructions.

H. Coordinate installation of roof drains and sumps and related flashings.

3.07 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for general requirements for field quality control and inspection.

B. Require site attendance of roofing and insulation material manufacturers daily during installation of the Work.

3.08 CLEANING

A. Remove bituminous markings from finished surfaces.

B. In areas where finished surfaces are soiled by bitumen or other source of soiling caused by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.

C. Repair or replace defaced or damaged finishes caused by work of this section.

3.09 PROTECTION

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 07550

SECTION 07900
CAULKING AND SEALANTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The work in this section includes furnishing all materials, labor, equipment, and incidentals required to perform all caulking, and related work necessary for the proper completion of the project as required by the Drawings and as specified herein.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 APPLICATION SCHEDULE

A. Caulk all exterior wall joints between frames in openings and adjacent materials, between masonry and cast in place concrete, expansion and control joints and all other joints shown on the Drawings or required for the completion of the work.

B. Caulk all interior joints between frames and masonry, at tops of masonry walls, between masonry and structural concrete and control joints, exterior window and door frames and all other joints shown on the drawings or required for the completion of the work.

C. Joints of similar nature to those indicated shall be sealed with same sealer, whether indicated on Drawings to be sealed or not.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's technical data for each joint sealer product required, including instructions for joint preparation and joint sealer application.
2. Manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available, for each product exposed to view.
3. Samples of each type and color of joint sealer required. Install joint sealer samples in 1/2 inch wide joints formed between two 6 inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealers in the Work.

1.04 QUALITY ASSURANCE

A. Applicable standards: Standards of the following, as referenced herein:

1. ASTM C 920-87 Standard Specification for Elastomeric Joint Sealants, 1987.

2. ASTM C 962-86 Standard Guide for Use of Elastomeric Joint Sealants, 1986.

B. Preinstallation Meeting: The contractor shall arrange a meeting with installer, sealer manufacturers' representatives, and other trades whose work affects installation of sealers at project site to review procedures and time schedule proposed for installation of sealers which is coordinated with other related work.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels showing manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.07 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of sealers under the following conditions:

B. When ambient and substrate temperature conditions are outside the limits permitted by sealer manufacturer or below 40 degrees F (4.4 degrees C).

C. When substrates are wet due to rain, frost, condensation, or other causes.

D. Joint Dimension Conditions: Do not proceed with installation of sealers when joint dimensions are less than recommended by joint sealer manufacturer for application indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Provide joint sealers manufactured by Polymeric Systems, Inc., 723 Wheatland Street, Phoenixville, PA 19460-3394. Telephone outside PA: 800-CAULK-IT; inside PA: 610-935-1170; FAX: 610-935-7123.

B. Other manufacturers considered equal shall include:

1. Pecora Corp
2. Protective Treatments, Inc.
3. Tremco, Inc.
4. Sonneborn Inc.

2.02 CAULKING

A. Silicone Sealant: PSI-631 Non Corrosive Silicone Sealant.

B. One-Part Urethane:

1. Gun-grade, oxygen-cured: PSI-901 One-Part Urethane Sealant.

C. Provide the following colors:

1. Sealant joints in masonry: Match mortar color.
2. Joints around doors, windows, louvers and other openings: Match color of adjacent wall material.
3. Joints in paving: Manufacturer's standard gray.

D. Primer: As recommended by caulking compound manufacturer.

E. Back-up Material: Closed cell foam polyethylene, or similar non-bituminous material as recommended by manufacturer of caulking compound and completely compatible with selected compound.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION AND INSTALLATION

A. Remove dirt, grease, mortar droppings and other foreign matter from substrate.

B. Require installer to inspect joints indicated to receive joint sealers for compliance with requirements for joint configuration, installation tolerances and other conditions affecting joint sealer performance. Do not allow joint sealer work to proceed until unsatisfactory conditions have been corrected.

3.02 CAULKING

A. Surface Preparation: Clean metal surfaces free of grease, oil, wax lacquer, and other foreign residue by wiping with a clean cloth moistened with a suitable solvent. Scrape or brush masonry surfaces clean. Apply appropriate primer to contact surfaces.

B. Joint Preparation: Joints to be caulked having a depth in excess of 3/8-inch shall be packed with back-up material. Round back-up material shall be sized to require 20 percent to 50 percent compression upon insertion. In joints not of sufficient depth to allow packing, install polyethylene bond-breaking tape at back of joint. Avoid lengthwise stretching of back-up material. Cut all corners, avoid wrapping around corners.

C. Application: Apply compound with pressure flow gun with nozzle of proper size and shape to suit width of joint, promptly after mixing and with sufficient pressure to fill joint. Apply as a continuous operation horizontally in one direction, and vertically from bottom to top, except joints having excessive widths where compound might sag, the joints shall be built up with successive beads. Finish joints smooth and slightly coved.

3.03 PROTECTION AND CLEANING

A. Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of substantial completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

B. Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

3.04 SCHEDULE OF JOINT SEALERS

A. General-Purpose Interior and Exterior Applications:

1. Sealer:
   a. One-part, gun-grade polyurethane.
2. Applications:
   a. Joints and recesses between adjacent constructions and, etc.
   b. Masonry control joints.
   c. Around penetrations in exterior walls.
   d. Under door thresholds, and at bottom of door frames.
   e. Wherever necessary to prevent infiltration of water or air into or through exterior

B. Other Exterior Applications:

1. Sealer:
   a. Neutral cure silicone.
2. Applications:
   a. Top edge of surface mounted counterflashing.

END OF SECTION 07900

SECTION 08110
STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Standard steel doors and frames.
2. Assemblies for fire-rated openings.

B. Related Sections:

1. Door hardware: Elsewhere in Division 8.
2. Painting: Division 9.

1.02 REFERENCES

A. SDI 100-1991 -- Recommended Specifications: Standard Steel Doors and Frames; Steel Door Institute; 1991.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's printed product information indicating compliance with specified requirements.

B. Shop Drawings: Submit drawings for fabrication and installation of steel doors and frames, including the following information:

1. Details of construction, joints, and connections.
2. Details of each frame type, including anchorage.
3. Elevations of each opening type.
4. Conditions at openings, including coordination with glass and glazing requirements.
5. Location and installation requirements of door hardware and reinforcements.
6. Schedule of openings coordinated with numbering system used in contract documents.

C. Quality Assurance Certification: Submit manufacturer's certification that products have been constructed and tested in full compliance with ANSI/SDI 100. As applicable, include test reports for core construction and reinforcing methods not specifically designated as acceptable by ANSI/SDI 100.

1.04 QUALITY ASSURANCE

A. Quality Standard: Comply with SDI 100.

B. Labeled Assemblies: At all locations where fire-rated door and frame assemblies are required, provide assemblies which comply with NFPA 80 and have been tested and labeled in accordance with ASTM E 152 by agency acceptable to governing authorities.

C. Coordination: Transmit copy of final shop drawings to wood door manufacturer to allow prefitting of wood doors to steel frames.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products in crates or cartons suitable for storage at the site.

B. Replace items damaged in delivery, unless damage is minor and can be repaired to match intact items, as determined by the Architect.

C. Store products under cover, raised above ground level, and stacked to prevent warping and to promote air circulation.

1. Prevent moisture from accumulating and remove saturated packaging before products can be damaged.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Provide products complying with requirements of the contract documents and made by one of the following:

1. Allied Steel Products, Inc.
2. Amweld Building Products, Inc.
3. Ceco Door Products, a Division of United Dominion.
4. Copco Door Company.
5. Mesker Door, Inc.
6. Pioneer Industries Division/CORE Industries, Inc.
7. Republic Builders Products Division/DESCO.
8. Steelcraft Manufacturing Company/Masco Industries.

2.02 MATERIALS

A. Steel Sheets, Galvanized: ASTM A 591, electrolytic zinc-coated, Class A, mill phosphatized.

B. Anchorages: Galvanized steel, minimum 18 gage.

C. Fasteners and Inserts: Units standard with manufacturer.

1. Exterior walls: ASTM A 153, hot-dip galvanized, Class C or D.

D. Paint:

1. Primer: Manufacturer's standard rust-inhibitive coating, suitable to receive finish coatings specified.

2.03 FABRICATION

A. General: Shop-fabricate assemblies to greatest extent possible, assuring that installed units will be without warp, twist, bow, or other defect in appearance or function.

B. Exposed Door Faces: Fabricate from cold-rolled steel.

C. Frames: Fabricate from cold-rolled or hot-rolled steel.

D. Edge Channels, Stiffeners, and Reinforcement: Fabricate from cold-rolled or hot-rolled steel.

E. Exterior Doors: Fabricate from electrolytic galvanized steel.

F. Seal top and bottom edges integrally with door construction, or use minimum 16 gage steel channels to form flush closure.

G. Exterior Frames: Fabricate from galvanized steel.

H. Exposed Screws and Bolts: Where required, provide only countersunk, flat Phillips-head fasteners.

I. Insulated Assemblies: At locations scheduled, provide insulating door and frame assemblies which have been tested in accordance with ASTM C 236 for thermal resistance.

1. U-value: 0.24 BTU per hour per square foot per degree F, minimum.

J. Hardware Preparation: Comply with DHI A115 series specifications for door and frame preparation, using final hardware schedule and templates from hardware supplier.

1. Reinforcement: Reinforce doors and frames for field-installed exposed hardware items.
2. Locations: Comply with final shop drawings.

K. Shop Painting:

1. Preparation: Clean surfaces thoroughly before beginning painting operations, removing rust, scale, oil, grease, and other contaminants.
2. Primer: Apply primer evenly to achieve full protection of all exposed surfaces.

L. Exposed Screws and Bolts: Where required, provide only countersunk, flat Phillips-head fasteners.

M. Insulated Assemblies: At locations scheduled, provide insulating door and frame assemblies which have been tested in accordance with ASTM C 236 for thermal resistance.

1. Maximum U-value: 0.24 BTU per hour per square foot per degree F.

N. Hardware Preparation: Comply with DHI A115 series specifications for door and frame preparation, using final hardware schedule and templates from hardware supplier.

1. Reinforcement: Reinforce doors and frames for field-installed exposed hardware items.
2. Locations: Comply with final shop drawings.

O. Shop Painting:

1. Preparation: Clean surfaces thoroughly before beginning painting operations, removing rust, scale, oil, grease, and other contaminants.
2. Primer: Apply primer evenly to achieve full protection of all exposed surfaces.

2.04 STEEL DOORS

A. General: Fabricate steel doors in accordance with requirements of SDI 100.

B. Exterior Doors:

1. Grade III - Extra Heavy-Duty, Model 1A - Full Flush (14 gage).

2.05 STEEL FRAMES

A. General: Fabricate steel frames for scheduled openings, in styles and profiles as shown, using concealed fasteners.

1. Minimum thickness: 16 gage interior; 14 gage exterior.
2. Construction: Mitered and welded corners.

B. Door Silencers: Drill stops to receive silencers.

1. Provide 3 silencers on strike jambs of single-swing frames.
2. Provide 2 silencers on heads of frames for pairs of doors.
3. Provide for 2 silencers on heads of frames for double egress doors.

C. Guards: Weld protective covers to back of hardware openings at locations where grout, plaster, or other materials might interfere with hardware operation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install steel doors, frames, and accessories to comply with manufacturer's recommendations.

1. Comply with detailed installation requirements of final shop drawings.

B. Frame Installation:

1. General: Adhere to provisions of SDI 105.

2. Place welded frames prior to construction of enclosing elements, braced securely to achieve plumb, planar installation. Remove braces after anchorages have achieved final set, leaving frames in smooth, undamaged condition.

3. Anchors: Provide 3 wall anchors per jamb at hinge and strike levels and minimum 18 gage base anchors.

4. Openings at in-place masonry: Fasten frames securely to masonry with machine screws and masonry anchorages.

5. Fire-rated openings: Comply with requirements of NFPA 80.

6. Metal stud partitions: Attach wall anchors to stud framing with tapping screws.

C. Fill all door frames with grout at all locations.

D. Door Installation:

1. General: Comply with requirements and clearances specified in SDI 100.

2. Fire-rated doors: Comply with NFPA 80 requirements and clearances.

E. Fixed Panel Installation:

1. Install fixed panels with concealed fasteners.

3.02 ADJUST AND CLEAN

A. Touch-Up: At locations where primer has been abraded or minor rusting has occurred, sand smooth and spray-apply compatible primer.

B. Final Operating Adjustments: Check hardware at all openings for proper operation of doors, making final corrections as required to assure that work of this section is complete and undamaged.

END OF SECTION 08110

SECTION 08331
OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SCOPE

A. Overhead coiling doors, operating hardware, exterior, electric operation.

B. Wiring from electric circuit disconnect to operator to control station.

1.02 RELATED REQUIREMENTS

A. Section 09900 - Paints and Coatings: Field paint finish.

B. Section 13851 - Fire Alarm System: Fire alarm interconnection.

C. Section 16155 - Equipment Wiring: Power to disconnect.

1.03 REFERENCE STANDARDS

A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2010.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2008.

C. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2005).

D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide general construction, component connections and details, electrical equipment, .

C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.

D. Samples: Submit two slats, 12" x 12" inch in size illustrating shape, color and finish texture.

E. Manufacturer's Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.

F. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.05 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Doors:

1. Overhead Door Company
2. Cornell Iron Works, Inc: www.cornelliron.com.
3. The Cookson Company: www.cooksondoor.com.
4. Wayne-Dalton, a Division of Overhead Door Corporation: www.wayne-dalton.com.

2.02 COILING DOORS

A. Exterior Coiling Doors: Steel slat curtain.

1. Capable of withstanding positive and negative wind loads of 20 psf, without undue deflection or damage to components.
2. Sandwich slat construction with insulated core of ridged Polyisocyanurate type insulation; insulation (u-) value: 0.50 BTU/hr sq ft deg F.
   a. Front slat 22 ga.; back slat 24 ga.
3. Nominal Slat Size: 2 inches wide x required length.
4. Finish: Factory painted, color as selected.
5. Guides: Angles; galvanized steel.
6. Hood Enclosure: As indicated; aluminum.
7. Electric operation.
8. Mounting: As indicated.

2.03 MATERIALS

A. Curtain Construction: Interlocking slats.

1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.

B. Steel Slats: Minimum 18 gage ASTM A653/A653M galvanized steel sheet.

C. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

D. Steel Guides: Formed from galvanized steel sheet, complying with ASTM A653/A653M.

1. Galvanizing: Minimum G90/Z275 coating.

E. Hood Enclosure: Internally reinforced to maintain rigidity and shape.

1. Minimum 22 gage.
2. Prime paint with polyester top coat.

F. Hardware:

1. Lock Cylinders: Specified in Section 08710.

G. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb nominal force to operate.

2.04 ELECTRIC OPERATION

A. Electric Operators:

1. Mounting: Side mounted.
2. High starting torque, reversible, constant duty, Class A insulated; overload protected; sized to operate door between 2/3 foot per second and 1 foot per second.
3. Motor Enclosure:
   a. Exterior doors: NEMA MG 1 Type 4; TEFC.
4. Motor Rating: 3/4 hp; continuous duty.
5. Motor Controller: NEMA ICS 6, full voltage, reversing magnetic motor starter.
6. Controller Enclosure: NEMA 250 Type 1.
7. Opening Speed: 9 to 12 inches per second.
8. Coordinate motor electric service criteria with building electrical supply.
9. Brake: Adjustable friction clutch type, activated by motor controller.
10. Manual override in case of power failure.

B. Control Station: Standard three button (OPEN-STOP-CLOSE) momentary control for each operator.

1. 24 volt circuit.
2. Mometary-contact, 3 button, labeled OPEN, CLOSE, and STOP.

C. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to reverse operator upon striking object, hollow neoprene covered.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Section 16155.

F. Complete wiring from disconnect to unit components.

G. Complete wiring from fire alarm system.

H. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.

I. Install perimeter trim and closures.

3.03 TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch.

C. Maximum Variation From Level: 1/16 inch.

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft straight edge.

3.04 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION 08331

SECTION 08710
FINISH HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding Doors
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Cylinders specified for doors in other sections.

C. Related Sections:

1. Section 08110 – Hollow Metal Doors and Frames.
2. Section 08810 – Glass and Glazing.
3. Section 09900 – Painting and Coating.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.03 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
3. Content: Include the following information:
   a. Type, style, function, size, label, hand, and finish of each door hardware item.
   b. Manufacturer of each item.
   c. Fastenings and other pertinent information.
   d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
   e. Explanation of abbreviations, symbols, and codes contained in schedule.
   f. Mounting locations for door hardware.
   g. Door and frame sizes and materials.
4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary Integrated Wiegand Access Control Products.

D. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.

E. Informational Submittals:

1. LEED Submittals: Manufacturer's product information and applicable sustainability program credits that are available to contribute towards a LEED rated project certification.
   a. Credit MR 4.1 and 4.2: Manufacturer's or fabricator's certificate indicating percentage of post-consumer recycled content by weight and pre-consumer recycled content by

weight for each Product specified under this Section. Use materials with recycled content such that the sum of the post-consumer recycled content plus one-half of the pre-consumer content constitutes an additional 10% beyond MR Credit 4.1 (total of 20% based on cost) of the total values of the material in the project as follows:

i) Floor Closers: 63%
ii) Pivots: 78%
iii) Cylindrical Locks: 58%
iv) Mortise Locks: 57%
v) Exit Devices: 54%
vi) Door Closers: 51%
vii) Overhead Stops: 46%

b. Low-Emitting Materials EQ 4.2: Provide products that reduce the quantity of indoor air contaminants that are odorous, irritating, and/or harmful to the comfort and well-being of installers and occupants; products shall not produce VOC emissions.

2. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.

G. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

1.04 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum 3 years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedules.

D. Source Limitations: Obtain each type and variety of Door Hardware specified in this Section from a single source, qualified supplier unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:

1. NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
2. Where indicated to comply with accessibility requirements, comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:
   a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
   b. Door Closers: Comply with the following maximum opening-force requirements indicated:
      i) Interior Hinged Doors: 5 lbf applied perpendicular to door.
      ii) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
   c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.
3. NFPA 101: Comply with the following for means of egress doors:
   a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
   b. Thresholds: Not more than 1/2 inch high.
4. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C.
   a. Test Pressure: Positive pressure labeling.

F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, arrange for manufacturers' representatives to hold a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by

installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.

2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.
5. Review the required inspecting, testing, commissioning, and demonstration procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.06 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.07 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship

within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Five years for exit hardware.
3. Ten years for manual door closer bodies.

1.08 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

B. Continuing Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.01 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

1. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
   a. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
2. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.
   a. Permanent cylinders, cores, and keys to be installed by Owner.

B. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.02 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity, unless otherwise indicated:
   a. Two Hinges: For doors with heights up to 60 inches.
   b. Three Hinges: For doors with heights 61 to 90 inches.
   c. Four Hinges: For doors with heights 91 to 120 inches.
   d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
   a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
   b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
   a. Exterior Doors: Heavy weight, non-ferrous, ball bearing hinges unless Hardware Sets indicate standard weight.
   b. Interior Doors: Standard weight, steel, ball bearing hinges unless Hardware Sets indicate heavy weight.
   c. Tornado Resistant Assemblies: At a minimum, provide heavy weight hinges with stainless steel screws used in accordance with and specified as part of a Severe Storm Shelter Opening meeting ICC 500 and FEMA 361.
4. Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:
   a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:
      i) Out-swinging exterior doors.
      ii) Out-swinging access controlled doors.
5. Acceptable Manufacturers:
   a. McKinney Products (MK), or equal.

2.03 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified automatic, self-latching, and manual flush bolts and surface bolts. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor. Furnish dust proof strikes for bottom bolts. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable. Provide related

accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

1. Acceptable Manufacturers:
   a. Rockwood Manufacturing (RO).
   b. Trimco (TC).
   c. Or equal.

2.04 CYLINDERS AND KEYING

A. General: All lock and cylinder housings shall accept Best SFIC 7-pim permanent cylinders.

B. Keying System: Owner will coordinate permanent cores directly with manufacturer's representative. Provide temporary removable cores at all exterior, mechanical room and storage room openings.

C. Key Quantity: Provide the following minimum number of keys:

1. Construction Control Keys: Two (2)
2. Construction keys: Five per building.

2.05 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified mortise locksets furnished in the functions as specified in the Hardware Sets. Locksets to be manufactured with a corrosion resistant, stamped 12 gauge minimum formed steel case and be field-reversible for handing without disassembly of the lock body. Lockset trim (including knobs, levers, escutcheons, roses) to be the product of a single manufacturer. Furnish with standard 2 3/4" backset, 3/4" throw anti-friction stainless steel latchbolt, and a full 1" throw stainless steel bolt for deadbolt functions.

1. Acceptable Manufacturers:
   a. Sargent Manufacturing (SA) – 9200 Series or 8200 Series as scheduled, or equal.

B. Lock Trim Design: As specified in Hardware Sets.

2.06 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
4. Dustproof Strikes: BHMA A156.16.

2.07 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
   a. Fire Exit Removable Mullions: Provide keyed removable mullions for use with fire exit devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252. Mullions to be used only with exit devices for which they have been tested.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Flush End Caps: Provide heavy weight impact resistant flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty trim with cold forged escutcheons, beveled edges, and four threaded studs for thru-bolts.
   a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets. Provided free-wheeling type trim where indicated.
   b. Where function of exit device requires a cylinder, provide an interchangeable core type keyed cylinder (Rim or Mortise) as specified in Hardware Sets.
6. Vertical Rod Exit Devices: Provide and install interior surface and concealed vertical rod exit devices as Less Bottom Rod (LBR) unless otherwise indicated.
7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.

1. Acceptable Manufacturers:
   a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
   b. Sargent Manufacturing (SA) - 80 Series.
   c. Or equal.

C. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish. Provide keyed removable feature, stabilizers, and mounting brackets as specified in the Hardware Sets. At openings designed for severe wind load conditions due to hurricanes or tornadoes, provide manufacturers approved mullion and accessories to meet applicable state and local windstorm codes.

1. Acceptable Manufacturers:
   a. Corbin Russwin Hardware (RU) - 700/900 Series.
   b. Sargent Manufacturing (SA) - 980S Series.
   c. Or equal.

2.08 DOOR CLOSERS

A. Door Closers, Surface Mounted (Commercial Duty): ANSI/BHMA 156.4, Grade 1 certified surface mounted, institutional grade door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck, closing sweep, and latch speed control valves. Provide non-handed units with high impact, non-corrosive plastic covers standard.

1. Acceptable Manufacturers:
   a. Sargent Manufacturing (SA) - 1431 Series, or equal.

2.09 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Acceptable Manufacturers:
   a. Rockwood Manufacturing (RO).
   b. Trimco (TC).
   c. Or equal.

2.10 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: :Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Acceptable Manufacturers:

1. Pemko Manufacturing (PE).
2. Reese Enterprises, Inc. (RS).
3. Or equal.

2.11 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.12 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.02 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.03 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.04 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.05 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.06 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. and provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.07 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.08 DOOR HARDWARE SCHEDULE

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

B. Refer to Section 080671, Door Hardware Schedule, for hardware sets.

C. Manufacturer's Abbreviations:

1. MK - McKinney
2. SA - Sargent
3. RO - Rockwood

4. BE - Stanley Security Solutions Inc (BE)
5. PE - Pemko

Hardware Schedule

JET MIX PUMP STATION
Set: A
Doors: 101, 102
Description: Exterior Entry/Exit - NEC

3	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
1	Exit Device	72-7P 8804 PSB	US32D	SA
1	Combinated Permanent Core	1E-7 as required	626	BE
1	Door Closer	SRI 1431 CPSH	EN	SA
1	Threshold	1715AK WS10SS		PE
2	Jamb Gasketing	290AS		PE
1	Head Gasketing	2891AS		PE
1	Sweep	315CN		PE
1	Rain Guard	346C		PE

Set: B
Doors: 105
Description: Exterior Pair

6	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
2	Flush Bolt	555	US26D	RO
1	Mortise Lock	3 72-7P 76 9250 LNJ LC	US32D	SA
1	Combinated Permanent Core	1E-7 as required	626	BE
2	Door Closer	SRI 1431 CPSH	EN	SA
2	Jamb Gasketing	290AS		PE
1	Head Gasketing	2891AS		PE
2	Sweep	315CN		PE
1	Rain Guard	346C		PE
1	Gasketing	S88D		PE

Notes: Overlapping astragal by door manufacturer.

Set: C
Doors: 106
Description: Exterior

3	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
1	Mortise Lock	3 72-7P 76 9250 LNJ LC	US32D	SA
1	Combinated Permanent Core	1E-7 as required	626	BE
1	Door Closer	SRI 1431 CPS	EN	SA
1	Threshold	1715AK WS10SS		PE
2	Jamb Gasketing	290AS		PE
1	Head Gasketing	2891AS		PE
1	Sweep	315CN		PE
1	Rain Guard	346C		PE

Set: D
Doors: 107
Description: Exterior

3	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
1	Mortise Lock	3 72-7P 76 9250 LNJ LC	US32D	SA
1	Combinated Permanent Core	1E-7 as required	626	BE
1	Door Closer	1431 O	EN	SA
1	Threshold	1715AK WS10SS		PE
2	Jamb Gasketing	290AS		PE
1	Head Gasketing	2891AS		PE
1	Sweep	315CN		PE
1	Rain Guard	346C		PE
1	Sweep	345C		PE

Set: E
Doors: 103
Description: Privacy - Toilet

3	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
1	Privacy Set	49 8265 LNJ	US32D	SA
1	Wall Stop	409	US32D	RO
3	Silencer	608		RO

Set: F
Doors: 104
Description: Overhead Door

1	SFIC Cylinder	1E-72	626	BE
1	Combinated Permanent Core	1E-7 as required	626	BE

Notes: Balance of hardware by door manufacturer.
Verify cylinder type and quantity with door manufacturer.

DIVERSION PUMP STATION
Set: 1.0
Doors: 100
Description: Exterior Entry/Exit - NEC

3	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
1	Exit Device	72-7P 8804 PSB	US32D	SA
1	Combinated Permanent Core	1E-7 as required	626	BE
1	Door Closer	SRI 1431 CPSH	EN	SA
1	Threshold	1715AK WS10SS		PE
2	Jamb Gasketing	290AS		PE
1	Head Gasketing	2891AS		PE
1	Sweep	315CN		PE
1	Rain Guard	346C		PE

Set: 2.0
Doors: 101
Description: Exterior Entry/Exit Pair - NEC

6	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
1	Removable Mullion	L980S	PCSA	
1	Exit Device	72-7P 8804 PSB	US32D	SA
1	Exit Device (exit only)	LD 8810	US32D	SA
1	SFIC Cylinder	1E-72	626	BE
2	Combinated Permanent Core	1E-7 as required	626	BE
2	Door Closer	SRI 1431 CPSH	EN	SA
1	Threshold	1715AK WS10SS		PE
2	Jamb Gasketing	290AS		PE
1	Head Gasketing	2891AS		PE
2	Sweep	315CN		PE
1	Rain Guard	346C		PE
1	Astragal	S771D		PE

Set: 3.0
Doors: 102, 103
Description: Exterior

3	Hinge	TA2314 SSF NRP 4-1/2" x 4-1/2"	US32D	MK
1	Mortise Lock	3 72-7P 76 9250 LNJ LC	US32D	SA
1	Combinated Permanent Core	1E-7 as required	626	BE
1	Door Closer	SRI 1431 CPS	EN	SA
1	Threshold	1715AK WS10SS		PE
2	Jamb Gasketing	290AS		PE
1	Head Gasketing	2891AS		PE
1	Sweep	315CN		PE
1	Rain Guard	346C		PE

END OF SECTION 08710

SECTION 09260
GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.01 SCOPE

A. Gypsum sheathing.

B. Joint treatment and accessories.

1.02 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.

C. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.

D. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

E. Test Reports: For all stud framing products that do not comply with ASTM C645 or C 754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.

PART 2 - PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies complying with ASTM C840 and GA-216.

B. Interior Partitions Indicated as Acoustic: Provide completed assemblies with the following characteristics:

1. Acoustic Attenuation: STC of 45-49 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90.

2.02 METAL FRAMING MATERIALS

A. Manufacturers - Metal Framing, Connectors, and Accessories:

1. Clarkwestern Dietrich Building Systems LLC: www.clarkdietrich.com.
2. Dietrich Metal Framing: www.dietrichindustries.com.
3. Marino\Ware: www.marinoware.com.
4. Phillips Manufacturing Company: www.phillipsmfg.com.

B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 10 psf.

1. Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
2. Studs: "C" shaped with flat or formed webs with knurled faces.
3. Runners: U shaped, sized to match studs.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:

1. American Gypsum: www.americangypsum.com.
2. Georgia-Pacific Gypsum LLC: www.gp.com/gypsum.
3. Lafarge North America Inc: www.lafargenorthamerica.com.
4. National Gypsum Company: www.nationalgypsum.com.
5. USG Corporation: www.usg.com.

B. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.

1. Application: Exterior sheathing, unless otherwise indicated.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Glass-Mat-Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
4. Core Type: Regular and Type X, as indicated.
5. Type X Thickness: 5/8 inch.
6. Regular Board Thickness: 5/8 inch.
7. Edges: Square, for vertical application.
8. Glass-Mat-Faced Products:
   a. CertainTeed Corporation; GlasRoc Brand.
   b. Georgia-Pacific Gypsum LLC; DensGlass Gold Sheathing.
   c. National Gypsum Company; Gold Bond Brand e2XP Extended Exposure Sheathing.
   d. Temple-Inland Inc; GreenGlass Exterior Sheathing.

2.04 ACCESSORIES

A. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless otherwise indicated.

1. Types: As detailed or required for finished appearance.

B. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.

1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.

C. Screws for Attachment to Steel Members From 0.033 to 0.112 inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.

D. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

3.03 BOARD INSTALLATION

A. Comply with ASTM C 840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.

1. Exception: Tapered edges to receive joint treatment at right angles to framing.

C. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.

D. Exterior Sheathing: Comply with ASTM C1280. Install sheathing vertically, with edges butted tight and ends occurring over firm bearing.

E. Exterior Soffit Board: Install perpendicular to framing, with staggered end joints over framing members or other solid backing.

F. Cementitious Backing Board: Install over steel framing members where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

G. Installation on Metal Framing: Use screws for attachment of all gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination.

H. Curved Surfaces: Apply gypsum board to curved substrates in accordance with GA-226.

I. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board and exterior gypsum soffit board with sealant.

3.04 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.

B. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.05 JOINT TREATMENT

A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, bedded and finished with chemical hardening type joint compound.

3.06 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION 09260

SECTION 09900
PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This Section of the Specifications includes, but is not necessarily limited to, standards for cleaning and painting structures and equipment described in the Drawings and Specifications. Furnish all materials, equipment, and labor necessary to complete the Work.

B. Section includes:

1. Surface preparation to receive finishes.
2. Painting, or otherwise finishing of all surfaces.

C. Related Work specified elsewhere:

1. Section 04400 - Masonry
2. Section 05120 - Structural Steel.
3. Section 05500 - Miscellaneous Metal.
4. Section 15050 - Basic Mechanical Materials and Methods.
5. Section 15060 – Piping and Appurtenances
6. Section 15100 - Valves and Piping Appurtenances

1.02 SUBSTITUTIONS

A. To the maximum extent possible, similar coatings shall be the products of one manufacturer. Guidelines for determination of acceptability of product substitutions are given in Instructions to Bidders. Contractors intending to furnish substitute materials or equipment are cautioned to read and comply strictly with these guidelines.

1.03 SUBMITTALS

A. All submittals and storage and protection provisions shall be in accordance with the requirements of the General Conditions, and the following.

1. Product data:
   a. Submit complete list of products for use; indicate compliance with:
      i) Mercury-free composition limits.
      ii) VOC limits, when mixed and thinned.
      iii) Indicate lead content.
   b. Indicate manufacturer, brand name, quality, and type paint for each surface to be finished correlate to specified item if from other manufacturer than specified item. Refer to the attached sample Paint Submittal Schedule for required submittal format.
   c. Include specified manufacturer's data sheets for reference to submitted manufacturer's data sheets.

d. Manufacturer's Safety Data Sheets (MSDS) for materials.

e. Intent of Contractor to use products specified does not relieve him from responsibility of submitting product line.

2. Samples:
   a. Color samples: Submit two sets of color samples from paint manufacturers proposed for use for color selections by Engineer.
   b. Brush-outs:
      i) Prepare actual brush-outs for each color paint, stain, or finish following final color schedule issuance.
      ii) Submit brush-outs in duplicate: minimum size, 120 sq. in.
      iii) Apply products in number of coats specified for actual Work.
      iv) Provide following substrates for brush-outs:
         a) Concrete unit masonry: Paint one face to simulate concrete and masonry.
         b) Metals for paint finish.

3. Quality control submittals:
   a. Certificates:
      v) Indicate interior paints are mercury-free.
      vi) Indicate lead content. Lead content in excess of 0.06% by weight of nonvolatile content calculated as lead metal is prohibited.
      vii) Indicate compliance with applicable VOC limits when mixed and thinned.

1.04 PROJECT MEETING

A. Prior to ordering any of the materials covered under this Section, the Contractor, Engineer, painting subcontractor, and paint manufacturer's representative shall attend a progress meeting in accordance with the General Conditions, and review the Work to be performed under this Section.

1.05 PAINTING REQUIREMENTS

A. Finish paint all exposed surfaces except anodized or lacquered aluminum, fiberglass reinforced plastic, stainless steel and copper surfaces. Items to be left unfinished or to receive other types of finishes are specifically shown on the Drawings or specified.

1. Unpainted Products: Full field cleaning and priming will be performed in accordance with specification requirements for unpainted products. Maintain adequate equipment on the site to assure proper cleaning.

2. Shop Primed Products:
   a. Manufactured products may be shop cleaned and primed. Shop cleaning must equal or exceed cleaning specified in the Painting Schedule. Clean as specified and reprime all abrasions, weld splatter, excessive weathering, and other defects in the shop prime coating.
   b. Manufacturers furnishing shop primed products shall certify that cleaning was performed in accordance with specification requirements and that the specified primer was used.
   c. Fully field clean and prime any shop primed products which the Engineer determines that were not cleaned in accordance with the Specifications prior to priming, that the wrong

primer was applied, that the primer was applied improperly, or has excessively weathered, or the product is otherwise unacceptable.

3. Finish Painted Products:
   a. Certain products such as electrical control panels and similar items may, with the approval of the Engineer, be furnished finish painted. Properly protect these products throughout the project to maintain a bright and new appearance. If the finish surfaces are defaced, weathered, or not of the selected color, repaint as necessary in accordance with the paint system manufacturer's written recommendations.

4. Hardware:
   a. Remove all electrical plates, surface hardware, fittings and fastenings prior to painting operations. These items are to be carefully stored, cleaned and replaced upon completion of Work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

1.06 SEQUENCING AND SCHEDULING

A. Schedule and coordinate this Work with other trades; proceeding until other Work and job conditions are proper to achieve satisfactory results is prohibited.

B. Examine specification sections for various other trades; be thoroughly familiar with Work required in other sections regarding painting.

PART 2 - PRODUCTS

2.01 MATERIAL SCHEDULE

A. Material schedules list pretreatment coats, wash coats, seal coats, prime coats, intermediate coats, finish coats and cover coats that comprise a complete and compatible system of surface protection for the particular substrate. Maintain the unity of these systems, making sure all coats applied to any surface are from the same system and same manufacturer. Verify with the manufacturer the compatibility of the materials used.

2.02 APPLICATION DATA

A. All applicable data currently published by the paint manufacturer relating to surface preparation, coverages, film thickness, application technique, drying and overcoating times is included by reference as a part of this Section. It will be the responsibility of the Contractor to obtain and fully understand the appropriate data sheets for the coatings specified.

2.03 MATERIALS

A. Paints shall be factory mixed and delivered to the job in unbroken original packages bearing the manufacturer's name and brand designation and shall be applied in strict accordance with the manufacturer's printed specifications. Two-component coatings shall be mixed in accordance with manufacturer's instructions. All two-component coatings, once mixed, shall be applied within the pot-life recommended by the manufacturer.

B. Unless otherwise specified, paints shall be of the best grade. All thinners, driers, varnish, etc., shall be of the best grade and shall be furnished by the coating manufacturer for use with the specified paints.

C. Paint thinners and tints: Products of same manufacturer as paints or approved by paint manufacturer for use with paint.

D. Patching compounds, and similar materials required for execution of Work: Pure, best quality products.

2.04 COLORS

A. Pump Stations:

1. The Engineer will select the colors to be used on the various portions of the Work. Provide color cards for the coatings proposed. Where more than one coat of paint is required, job tint the paint for each undercoat off-shade to show complete coverage.
2. Paint inside of ductwork flat black for entire area visible through ceiling openings. Paint underside of ductwork and other above ceiling items flat black for entire area visible through ceiling openings.
3. Paint exposed pipes and ductwork for HVAC systems same as adjacent ceiling surfaces.
4. Paint process piping per colors specified in schedule.

PART 3 - EXECUTION

3.01 GENERAL

A. Adequately protect other surfaces from paint and damage. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Repair damage as a result of inadequate or unsuitable protection.

B. Protection: Cover finished Work of other trades, surfaces not being painted concurrently, and prefinished items.

C. Application of materials in spaces where dust is being generated is prohibited.

3.02 PRODUCT HANDLING

A. Delivery

1. Deliver materials in original, sealed containers of the manufacturer with labels legible and intact.
2. Each container shall be clearly marked or labeled to show paint identification, paint type and color, date of manufacture, batch number, analysis or contents, identification of all toxic substances, and special instructions.

B. Storage

1. Store only acceptable project materials on the project site.

2. Store material in a suitable location and in such a manner as to comply with all safety requirements including any applicable federal, state and local rules and requirements. Storage shall also be in accordance with the instructions of the paint manufacturer and the requirements of the insurance underwriters.

3. Restrict storage area to paint materials and related equipment.

4. Place any materials, which may constitute a fire hazard in closed metal containers and remove daily from the project site.

5. Maintain neat, clean conditions in storage area; remove used rags from work areas at end of each day's work; store rags in closed containers.

6. Close containers at end of each day's Work. Leave no materials open.

7. Safety precautions:
   a. Provide temporary fire protection equipment in materials storage area. Mark fire protection equipment location for quick access.
   b. Prohibit smoking in storage area; post signs in visible location adjacent to and within storage area.

3.03 CLEANING AREA

A. Construct a temporary shed no smaller than 40 feet wide and 60 feet long for field cleaning, including blasting and priming operations. Maintain this area for all non-fixed painting operations until all such work has been completed and approved. Provide all fixtures and appurtenances required to perform the work including fixtures to support the work off the ground and proper storage facilities.

3.04 ENVIRONMENTAL CONDITIONS

A. Environmental conditions, which affect coating application include, but are not necessarily limited to, ambient air temperature, surface temperature, humidity, dew point and environmental cleanliness. Comply with the manufacturer's recommendations regarding environmental conditions under which coatings may be applied.

3.05 SURFACE PREPARATION

A. General: All surfaces shall be thoroughly clean, dry, and free from oil, grease or dust. All fabricated metal products shall have all weld flux and weld spatter removed and sharp peaks in weld ground smooth. The Engineer will inspect the surface preparation prior to the application of coatings. If the preparation is found to be satisfactory, a written order will be given to proceed with coatings.

B. Gypsum board:

1. Fill narrow, shallow cracks and small holes with patching plaster or non-shrinking spackling compound. Allow to dry; sand smooth without raising gypsum board paper nap.

2. Apply U.S. Gypsum Company, Sheetrock First Coat at 300-500 SF per gallon in accord with manufacturer's installation instructions. Allow to dry prior to prime coat application.

C. Ferrous Metals: Standards for the surface preparation of ferrous metals required in the Material Schedules are the standards of the Steel Structures Painting Council (SSPC, SP-1 through SP-10).

Inspection of these surfaces will be evaluated by field comparison with visual comparator panels. These panels shall be securely wrapped in clear plastic and sealed to protect them from deterioration and marring.

1. Delivery primer on structural steel shall be removed prior to beginning painting work specified.

D. Galvanized metal: Wash with xylol to remove grease, oil, and contaminants; wipe dry with dry cloth.

E. Concrete Masonry Unit Surfaces:

1. Clean thoroughly by brushing, scraping and sanding or grinding slick areas. Remove loose or projecting mortar, solvent wash oil, grease, paint spots before applying block filler.

3.06 APPLICATION

A. Conditions: No paint shall be applied upon damp or frosty surfaces, or in wet or foggy weather. No paint shall be applied in temperatures below 40 F. or when freezing (32 F.) is predicted within 24 hours of application, or under temperature or humidity conditions not recommended by the manufacturer.

B. Surface Preparation: After specified surface preparation, all surfaces shall be brushed free of dust or foreign matter. Surfaces shall be completely dry before any paint is applied.

1. Apply materials only when moisture content of surfaces is within manufacturer's recommended range.

C. Application: Paint shall be evenly spread in the proper thickness so that there shall be no drops, runs or sagging of the coating. Where runs and drops do occur, they shall be removed and the surface re-coated to the satisfaction of the Engineer. Sufficient time, as directed by the manufacturer, shall be allowed for the paint to dry before the application of succeeding coats.

1. Apply materials in accord with manufacturer's approved product data to achieve specified DFT.
2. Apply materials using clean brushes, rollers, or spray equipment. Limit paint spraying only to those materials recommended by manufacturer to be sprayed with no loss of performance, durability, or color.
3. Apply materials at rate not exceeding manufacturer's recommendations for surface being coated, less ten percent for losses.
4. Sand and dust between coats to remove defects visible from 5' - 0" distance. Tint primer and intermediate coats slightly to provide slight contrast.
5. Finish coats: Smooth, free of brush marks, streaks, laps or pile-up of paint, skips, or missed areas.
6. Make coating edges adjoining other materials or colors sharp and clean without overlapping.
7. Primer coats may be omitted for surfaces specified to receive factory applied primer if finish coats are compatible with primer. Substitute bond coat recommended by paint manufacturer for specified primer coat if finish coats are not compatible.

8. Refinish entire ceiling surface where portion of finish on gypsum board ceiling is damaged or unacceptable.

D. Protection of Work Area: Use drop cloths or other suitable means to protect other surfaces of the structure or equipment in place. Upon completion of the Work, remove all paint spots from surfaces as directed by the Engineer.

E. Inspection: The Engineer will inspect each coat prior to the application of subsequent coats. If the work is found to be satisfactory, a written order will be given to proceed. Application of

additional coats until completed coat has been inspected is prohibited. Only inspected coats of paint will be counted in determining the number of coats applied.

F. Defective Work: Remove and replace, at the direction of the Engineer, any painting work found to be defective or applied under adverse conditions.

3.07 PAINTING SCHEDULE

A. Surfaces not requiring painting:

1. Face brick.
2. Fiberglass doors and frames.
3. Louvers.
4. Prefinished surfaces and items.
5. Concealed ductwork, conduit, and piping.

B. The Painting Schedule summarizes the painting systems to be applied to the various surfaces.

1. SAMPLE PAINT SUBMITTAL SCHEDULE

System	Specification	Item	Surface Prep	Primer	Finish & Touch Up	Color
A	SS 04400	Masonry Paint	SSPC 2 or 3 Pressure Washing to Remove Loose Concrete & Dirt	Tnemec Series 130	2 Coats of Tnemec Series N69F at 4-6.0 mils per coat	To be selected
B	SS 05120	Interior structural steel, joist and underside of metal decking	SSPC 6 for Non-Immersion	Not Required	2 coats Tnemec Series 69 @ 6-8.0 mils	To be selected
C	SS 05500	Misc. Metals	SSPC 6 for Non-Immersion	Not Required	2 Coats of Tnemec Series N69F Non-	To be selected

System	Specification	Item	Surface Prep	Primer	Finish & Touch Up	Color
					Immersion at 4-6.0 mils	
D	SS 09260	Exterior Gypsum Board	S Joint compound and sand smooth and feather edge	Tnemec Series 151- Elasto Grip	2 coats of Tnemec Series7 @ 2-3.0 mils per coat	To be selected
E	SS 15060	Ductile Iron Pipe	SSPC 6 for Non-Immersion	Tnemec Series N69F	2 Coats of Tnemec Series N69F for Non-Immersion at 4-6.0 mils per coat	To be selected
F	SS 15060	Ductile Iron Pipe	SSPC 10 for Immersion	Tnemec Series N69F	2 Coats of Tnemec Series N69F for Immersion at 4-6.0 mils per coat	To be selected
G	SS 15100	Valves & Operators	Lightly Sand	Tnemec Series N69F	2 Coats of Tnemec Series N69F for Immersion at 4-6.0 mils	To be selected
H	SS 11199	Pumps & Drives	Lightly Sand	Tnemec Series N69F	2 Coats of Tnemec Series N69F for Immersion at 4-6.0 mils per coat	To be selected
I	SS 05120	Exterior bridge crane supporting steel, bridge crane assembly and odor control support bridge and framing	SSPC 6 for Non-Immersion	Tnemec Series N69F	1 Coat of Series 1075U 4 mils	To be selected

2. PAINTING SCHEDULE

Surfaces	Substrate Materials	Paint Material/Schedule
Ceilings	Gypsum Board	
Walls		
	CMU Block	131
Interior Structural Steel, joists and underside of metal decking	Galvanized Metal	140
	Ferrous Metal	140
Piping, piping supports, valves and pumps	Galvanized Metal	141
	Ferrous Metal	141
Exterior bridge crane supporting steel, bridge crane assembly and odor control support bridge and framing	Ferrous Metal	240

3. PIPE IDENTIFICATION COLOR SCHEDULE

Pipe System	Legend Symbol	Generic Color	Paint Color	Letters and Arrows	Stencil Text
Raw Sewage	RS	Light Brown		Black	Raw Sewage
Non-Potable Water	NPW	Medium Blue		Black	Non-Potable Water
Drain	PD	Light Brown		Black	Drain
Potable Water	PW	Light Blue		Black	Potable Water
Vent	V	Light Blue		Black	Vent

MATERIAL SCHEDULE

MATERIAL SCHEDULE
131

TYPE: EPOXY

USE: INTERIOR MASONRY AND CONCRETE

SURFACE PREPARATION: CC-I

TNEMEC

FIRST COAT: EPOXY-POLYMIDE FILLER

SECOND COAT: SERIES N69F HI-BUILD EPOXOLINE - 4.0 MILS DRY

THIRD COAT: SERIES N69F HI-BUILD EPOXOLINE - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

KOPPERS

FIRST COAT: CONCRETE AND MASONRY FILLER

SECOND COAT: HI-GARD EPOXY - 4.0 MILS DRY

THIRD COAT: HI-GARD EPOXY - 4.0 MILS DRY

* MINIMUM 8.0 MILS DRY

NOTES:

1. IF MINIMUM MIL THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN, ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

a. Sherwin-Williams Company.

MATERIAL SCHEDULE
140

TYPE: POLYAMIDOAMINE EPOXY

USE: FERROUS METAL SURFACES AND STRUCTURAL STEEL, METAL JOISTS AND UNDERSIDE OF METAL DECKING LOCATED INSIDE A BUILDING WHICH ARE NOT SUBMERGED. NOT FOR USE WITH PROCESS EQUIPMENT.

SURFACE PREPARATION: SSPC SP-6

TNEMEC

FIRST COAT: SERIES N69F EPOXOLINE II - 6.0 - 8.0 MILS*

SECOND COAT: SERIES N69F EPOXOLINE II - 6.0 - 8.0 MILS*

* MINIMUM DRY FILM THICKNESS

NOTES:

1. IF MINIMUM TOTAL DRY FILM THICKNESS OF 14.5 MILS IS NOT ACHIEVED IN THE NUMBER OF COATS SPECIFIED, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

a. Koppers.
b. Sherwin-Williams Company.

MATERIAL SCHEDULE
141

TYPE: HIGH BUILD EPOXY

USE: PROVIDE THE FOLLOWING COATING SYSTEM FOR FERROUS METAL SURFACES ON ALL MECHANICAL EQUIPMENT AND ACCESSORIES INCLUDING BUT NOT LIMITED TO: PUMPS, VALVING AND OTHER PROCESS EQUIPMENT EXPOSED STEEL PIPE.

SURFACE PREPARATION: SSPC-SP10 NEAR WHITE BLAST-IMMERSION SERVICE

TNEMEC

FIRST COAT: SERIES N69F HI-BUILD EPOXOLINE II 4.0-6.0 MILS DRY

THIRD COAT: SERIES 66 HI-BUILD EPOXOLINE II 4.0-6.0 MILS DRY

* MINIMUM TOTAL DRY FILM THICKNESS 10.5 MILS

NOTES:
1. IF MINIMUM TOTAL DRY FILM THICKNESS IS NOT ACHIEVED IN THE NUMBER OF COATS SHOWN, ADDITIONAL COATS SHALL BE APPLIED AT NO ADDITIONAL COST TO THE OWNER.

2. PRODUCTS OF THE FOLLOWING MANUFACTURERS SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES:

a. Koppers.
b. Sherwin-Williams Company.

MATERIAL SCHEDULE
240

TYPE: ALIPHATIC ACRYLIC POLYURETHANE

USE: EXTERIOR OF BRIDGE CRANE SUPPORTING STEEL, BRIDGE CRANE ASSEMBLY AND ODOR CONTROL SUPPORT BRIDGE AND FRAMING

SURFACE PREPARATION: SP6

TNEMEC

FIRST COAT (SHOP PRIMER): SERIES N69F HI BUILD EPOXOLINE 11 – 4.0 MILS DRY*
EPOXOLINE PRIMER 2.0 MILS

SECOND COAT (SHOP COAT): SERIES N69F HI BUILD EPOXOLINE 11 – 4.0 MILS DRY*

THIRD COAT: SERIES 1075U ENDURA SHIELD 11 – 4.0 MILS DRY*

*MINIMUM 12.0 MILS DRY

NOTES:

IF MINIMUM DRY FILM THICKNESS IS NOT ACHIEVED IN NUMBER OF COATS SHOWN ADDITIONAL COATS WILL BE APPLIED AT NO ADDITIONAL EXPENSE TO CITY.

PRODUCTS OF THE FOLLOWING MANUFACTURES SIMILAR IN TYPE, COLOR, SOLIDS AND QUALITY TO THE PRODUCTS SPECIFIED ABOVE ARE ACCEPTABLE FOR USE, SUBJECT TO APPROVAL OF PRODUCT LIST AND SAMPLES.

Sherwin Williams Company.

Valspar.

PPG Industries. Inc.

END OF SECTION 09900

SECTION 09960
HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. High performance coatings.

B. Permanent Protective Barrier coating

C. Special preparation of surfaces.

1.02 REFERENCE STANDARDS

A. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).

B. SSPC-SP 3 - Power Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).

C. SSPC-SP 6 - Commercial Blast Cleaning; Society for Protective Coatings; 2006.

1.03 SUBMITTALS

A. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1. Manufacturer's Certification: Provide certificates signed by manufacturer or manufacturer's representative certifying that the materials to be installed comply in all respects with the requirements of this specification, and that the applicator is certified and approved to install the materials in accordance with manufacturer's specifications.

C. Maintenance Data: Include cleaning procedures and repair and patching techniques.

D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Coating Materials: 10 gallon of each type and color.
2. Label each container with manufacturer's name, product number, color number, and room names and numbers where used.

E. Manufacturer's Field Report: Provide copy of report from manufacturer's representative confirming that the surfaces to which Protective Barrier is to be applied are in a condition suitable to receive same.

1.04 QUALITY ASSURANCE

A. Maintain one copy of each referenced document that applies to application on site.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

C. Applicator Qualifications High Performance Coatings: Company specializing in performing the work of this section with minimum 5 years documented experience.

D. Manufacturer Permanent Protective Coating: Provide products of manufacturer with no less than 5 years experience in manufacturing the silica sealant materials for the required work. Manufacturers that cannot provide the performance test data specified herein will not be considered for the project.

E. Applicator: Permanent Protective Coating applicator shall be certified at a Field Tech Level in the installation of SilTanium silica coating materials as demonstrated by previous successful installations, and shall be approved by the manufacturer in writing.

F. Pre-Installation Conference: Prior to installation of SilTanium Coatings, conduct meeting with applicator, installers of work adjacent to, Architect/Engineer, owner's representative, and SilTanium Corporation's representative to verify and review the following:

1. Project requirements for SilTanium Coating Application as set out in Contract Document.
2. Manufacturer's product data including application instructions.
3. Substrate conditions, and procedures for substrate preparation and SilTanium installation.
4. Installation scheduling, timing, and coordination with adjacent trades.

G. Technical Consultation: The SilTanium Corporation representative shall provide technical consultation on coating application.

H. Compliance: Comply with manufacturer's product data regarding condition of substrate to receive coating, weather conditions before and during installation, and protection of the installed coating system.

1.05 MOCK-UP

A. Provide mock-up, 8 feet long by 4 feet wide, illustrating coating, for each specified coating.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.06 FIELD CONDITIONS

A. Do not install materials when temperature is below 55 degrees F or above 120 degrees F. air surface and material.

B. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.

C. Provide lighting level of 80 ft candles measured mid-height at substrate surface.

D. Restrict traffic from area where coating is being applied or is curing.

1.07 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

B. Warranty: Include coverage for bond to substrate.

C. Manufacturer's Warranty Permanent Protective Coating: Manufacturer shall provide standard product warranty executed by authorized company official. Term of warranty shall be 3 years from Date of Substantial Completion.

D. Applicator's Warranty: Applicator shall warrant the coating installation against defects caused by faulty workmanship or materials for a period of 3 years from Date of Substantial Completion. The warranty will cover the surfaces treated and will bind the applicator to repair, at his expense, any and all failures of the treated surfaces which are not due to structural weaknesses or other causes beyond applicator's control such as fire, earthquake, tornado and hurricane and other environmental issues contained within the structure. The warranty shall read as follows:

1. Warranty: The applicator warrants that, upon completion of the work, surfaces treated with the SilTanium coating will be and will remain free from failure resulting from defective workmanship or materials for a period of 3 years from Date of Substantial Completion. In the event that failure occurs within the warranty period from such causes, the applicator shall, at his sole expense, repair, replace or otherwise correct such defective workmanship or materials. Applicator shall not be liable for consequential damages and applicator's liability shall be limited to repair, replacement or correcting of defective workmanship or materials. Warranty full details available on SilTanium Technical Data Sheet. Applicator shall have no responsibility with respect to failure or other defects caused by structural failure or movement of the structure, or any other causes beyond Applicator's control.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. High-Performance Coatings:

1. PPG Architectural Finishes, Inc: www.ppgaf.com.
2. Sherwin-Williams Company; HydroGloss - Single Component WB Urethane: www.protective.sherwin-williams.com/industries or equal and is basis of design.
3. Tnemec Company, Inc: www.tnemec.com.

2.02 HIGH-PERFORMANCE COATINGS

A. Provide coating systems that meet the following minimum performance criteria, unless more stringent criteria are specified:

1. Abrasion Resistance: 145 mg loss, when tested in accordance with ASTM D4060, CS17 whell, 1000 cycles, 1 kg load.
2. Impact Resistance: >160 in.lbs, when tested in accordance with ASTM G14.
3. Adhesion: 850 psi, when tested in accordance with ASTM D4541.

4. Water Resistance: Passess, when tested in accordance with ASTM D4587, QUV-A, 3,000 hours.

5. Graffiti Resistance: Level 3 when tested in accordance with ASTM D6578.

2.03 MATERIALS

A. Coatings - General: Provide complete multi-coat systems formulated and recommended by manufacturer for the applications indicated, in the thicknesses indicated; number of coats specified does not include primer or filler coat.

B. Single Component, high performance, acrylic/polyester waterbased urethane; providing excellent UV resistance.

1. Product: HYDROGLOSS Single Component Waterbased Urethane - B65W181 manufactured by Sherwin Williams.

2. Filler for Concrete Masonry: LOX-ON Block Surfacer manufactured by Sherwin Williams.

3. Product Characteristics
   a. Finish: Gloss
   b. Volume Solids: 34%+/- 2%.
   c. Weight Solids: 43% +/- 2%.
   d. VOC (EPA Method 24): <250 g/L; 2.0 lb/gal
   e. Reducer/Clean-up: Water

C. Proprietary Products: SilTanium silica coating materials as follows:

1. SilTanium Corporation, SilTaniumÒ Coatings
   a. CC- Concrete
   b. AG- Anti-Graffiti
   c. Substitutions: No substitutions permitted.
   d. Source Quality: Obtain proprietary SilTaniumÒ products from the single manufacturer.
   e. For proprietary or semiproprietary specification, delete descriptive requirements below that are determined by product designations inserted above.

D. Protective Floor Coating: ASTM C-1027, ASTM C-1028, ASTM D 968-05

1. Installation: 1.0 to 2.5 mil wet film thickness yielding a 0.5 to 1.0 mil dry film thickness

E. Wearing Surface: smooth

F. Coverage: Proportions (by Volume) for example:

1. 150-300 square feet per gallon (Brick, Paver and Concrete)

2. 500 to 1,000 square feet per gallon (Tile and Grout and Painted Concrete)

G. Primers: As recommended by coating manufacturer for specific substrate, unless otherwise specified.

H. Shellac: Pure, white type.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that substrate surfaces are ready to receive work as instructed by the coating manufacturer. Obtain and follow manufacturer's instructions for examination and testing of substrates.

C. Cementitious Substrates: Do not begin application until substrate has cured 28 days minimum and measured moisture content is not greater than 16 percent.

3.02 PREPARATION

A. Clean surfaces of loose foreign matter.

B. Remove substances that would bleed through finished coatings. If unremovable, seal surface with shellac.

C. Remove finish hardware, fixture covers, and accessories and store.

D. Surface must be clean, dry and in sound condtion. Remove all oil, dust, grease, dirt, loose rust and other foreigh material to ensure adequate adhesion.

E. Minimum recommended surface preparation:

1.	Iron & Steel:	SSPC-SP2.
2.	Aluminum:	SSPC-SP-1
3.	Galvanizing:	SSPC-SP-1
4.	Concrete & Masonry:	SSPC-SP13/NACE 6 or ICRI No. 310.2, CSP 1-3

F. Ferrous Metal:

1. Remove loose rust, loose mill scale, and other foreign substances using hand tools according to SSPC-SP 2.

G. Concrete and Masonry:

1. Surface should be thoroughly clean and dry. Concrete and morar must be cured at least 28 days @75 degrees F (24C) Remove all loose mortar and foreighn material. Surface must be free of latiance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement and hardeners. Fill bug holes, air pockets, and other voids.

H. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.03 PRIMING

A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

B. Concrete: Prior to priming, patch with masonry filler to produce smooth surface.

C. Concrete Masonry: Apply masonry filler to thickness required to fill holes and produce smooth surface; minimum thickness of 40 mils.

3.04 COATING APPLICATION

A. Apply coatings in accordance with manufacturer's instructions, to thicknesses specified.

B. Apply in uniform thickness coats, without runs, drips, pinholes, brush marks, or variations in color, texture, or finish. Finish edges, crevices, corners, and other changes in dimension with full coating thickness.

C. Apply SilTanium silica coating per manufacturer's specifications.

1. Apply coatings by brush, roller, low-pressure spray or other applicators according to coating manufacturer's written instructions. Use brushes or rollers only for exterior coating and where the use of other applicators is not practical.
2. Maintain a wet edge at all times.
3. Transparent (Clear) Finish: Use single coat to produce a smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, or other surface imperfections.

3.05 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

B. Clean surfaces immediately of overspray, splatter, and excess material.

C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.06 PROTECTION

A. Protect finished work from damage.

END OF SECTION 09960

SECTION 10440
IDENTIFYING DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall furnish all the materials for and shall properly erect and install all identifying devices at the locations determined by the Engineer, and as specified herein.

B. This shall include all identification signs and warning signs, including supports, fastening devices, and accessories, and all labor, materials, tools, and appurtenances required to complete the Work.

C. It is the intent of this Specification that the installation shall be complete in all respects and ready for use. The Contractor shall be responsible for all incidental details and for any special construction necessary to complete the work in an acceptable manner.

D. Related Work specified elsewhere:

1. Section 10520 - Fire Extinguishers.
2. Section 15060 - Piping and Appurtenances.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of sign required.

B. Samples: Submit samples of each sign form and materials showing finished, colors, surface textures and qualities of manufacturer and design of each sign component including graphics.

1.03 QUALITY ASSURANCE

A. Uniformity of manufacturer: For each sign form and graphic image process indicated furnish products of single manufacturer.

B. Quality of signage shall be not less than ASI-SPE construction.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Identifying devices shall be of the type and materials specified for each category. Unless otherwise indicated, signs shall be the manufacturer's stock items.

B. Life Safety Signs: Signs shall be butyrate with red lettering on white background, and conforming to OSHA regulations. Sign denoting fire extinguisher location shall be vinyl with pressure-sensitive adhesive backing.

1. NO SMOKING: Located at all entrance doors. Size – 7-in. x 10-in.
2. FIRE EXTINGUISHER: Located above all extinguishers. Size – 4-in. x 12-in.

3. CONFINED SPACE – Located at all entrances to confined spaces. Size – 14-in. x 10-in.

4. OVERHEAD CRANE – Located at each crane, two signs per crane at location directed by Engineer. Size – 14-in. x 10-in.

C. Interior and Directional Signs: Signs shall be ASI/2 type A, constructed of 0.015-inch vinyl laminated to 1/4-inch acrylic backing. Letters shall ASI/2 pressure-sensitive vinyl letters. Signs shall have 1-inch border around perimeter.

1. Two (2) each: Electrical, Mechanical and Control Rooms. Size: 10-in. x 14-in.

2. EXIT. Shall be posted at all exterior doors. Size: 10-in. x 14-in.

3. RESTROOM. Shall be posted at the restroom. Size: 7-in. x 5-in.

D. Exterior Signs: Signs shall be as listed below.

1. NO PARKING: No parking sign shall be 12" x 18" embossed steel with cast iron base and 1-inch diameter pipe standard, 36-inches high, with black enamel finish. Location to be determined by the Engineer.

2. NO TRESPASSING AUTHORIZED PERSONNEL ONLY. Sign shall be 7-in. x 5-in. with a white background and red and black design. Four signs shall be supplied. Location to be determined by the Engineer.

E. Environmental Signs. Signs shall be butyrate with white background and red and black design, conforming to OSHA regulations.

1. NON-POTABLE WATER DO NOT DRINK: Signs shall be posted at all hose bibs and post and yard hydrants on the site and in the buildings. Signs shall be 7-in x 5-in.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Locate sign units and accessories where directed, using mounting methods of the type described and in compliance with the manufacturer's instructions.

1. Install signs level, plumb and at the height indicated, with sign surfaces free from distortion or other defects in appearance.

3.02 CLEANING AND PROTECTION

A. At completion of the installation, clean soiled sign surfaces in accordance with the manufacturer's instructions. Protect units from damage until acceptance by the Engineer.

END OF SECTION 10440

SECTION 10520
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all wall mounted fire extinguishers. All equipment shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Related Work specified elsewhere:

1. Section 10440 - Identifying Devices.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's certification.
2. Manufacturer's data and installation instructions.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. OSHA, Occupational Safety and Health Act.
4. NFPA, National Fire Protection Association.

1.04 QUALITY STANDARDS

A. The fire extinguishers shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been designed in accordance with these specifications, in accordance with NFPA10, and is a suitable application for these service conditions.

C. Manufacturer's offering products that comply with these specifications include:

1. Larsen's Manufacturing Co.
2. J. L. Industries
3. Modern Metal Products by Muckle
4. Or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 FIRE EXTINGUISHERS

A. Provide fire extinguishers in accordance with the following:

Product	Hand held, dry chemical fire extinguisher
Capacity	10 Pounds
Class	C
Extinguishing agent (As indicated) Electrical Room and Mechanical Equipment Room	Potassium Bicarbonate (11)
Mounting	Wall Brackets

B. Unit shall be UL labelled. Unit shall have pressure indicating gauge rated for Class C fires.

C. Service, charge and tag each fire extinguisher not more than ninety-five (95) calendar days prior to the Date of Substantial Completion of the Work as that Date is established by the Engineer.

D. A universal emergency sign shall be attached to building structure above each fire extinguisher.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.02 INSTALLATION

A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.

B. Install the work of this Section in strict accordance with the original design, the approved Shop Drawings, pertinent requirements of governmental agencies having jurisdiction, and the manufacturer's recommended installation procedures as approved by the Engineer.

END OF SECTION 10520

SECTION 11199
SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of all submersible pumps including wet and dry pit installations and their respective variable frequency drives which are specified elsewhere. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications and the manufacturer's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Section 09900 - Painting.
2. Section 15060 - Piping and Appurtenances
3. Section 15100 - Valves and Piping Appurtenances
4. Division 13 - Instrumentation and Control
5. Division 16 - Electrical

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Relevant experience references per requirements of paragraph 1.03 B.
2. Manufacturer's Certifications.
3. Mill certificates of materials used in the construction of pumps showing ASTM compliance shall be submitted to the Engineer prior to factory witness testing of the pumps.
4. Factory testing procedures, sketch of test setup and results of certified performance and witness testing.
5. Field testing procedures, equipment to be used and calibration certificates. Submit a minimum of 2 weeks prior to field testing.
6. Manufacturer's data: Dimensions; materials; size and location of all loads imposed on supporting structures; size and location of any concrete blockouts; size and location of anchor bolts, certified setting plans, with tolerances, for anchor bolts and any required

clearances. Provide details of all pump protective control devices, leakage sensors, bearing temperature sensors, motor temperature sensors, etc. to define all components to be included.

7. Data, regarding pump and motor characteristics and performance including:
   a. Guaranteed performance curves (prior to fabrication and testing) based on actual shop tests of mechanically similar pumps, showing they meet specified requirements for head, capacity, horsepower, efficiency and NPSHR.
   b. Provide curves for a single unit only for units of same size and type.
   c. Provide catalog performance curves at required speed showing maximum and minimum impeller diameters available.
   d. Variable speed curves for pumps controlled by variable speed drives.
8. Submit curves for guaranteed performance, certified test and witness tests on 8-1/2-in. by 11-in. sheets, one curve per sheet.
9. Certified results of hydrostatic testing.
10. Certified results of dynamic balancing.
11. Pump shop test results.
12. Motor shop test results.
13. Bearing Life: Certified by the pump manufacturer. Include design data.
14. Complete wiring and control diagrams, wiring sizes and wiring specifications.
15. List of recommended spare parts, including those specified herein.
16. Qualifications of field service technician.
17. Location of nearest authorized pump service center.
18. Recommendations for short and long-term storage.
19. The pump manufacturer shall submit a start cycle calculation for the specific pump/motor combination with the specific piping/discharge system required by this Project and as specified herein. The calculation shall graphically present system load torque and motor start torque as a function of time throughout the motor/pump start cycle. The calculation shall prove satisfactory motor start (breakdown torque exceeding load torque) under anticipated starting conditions. For pumps equipped with variable frequency drives load torque shall be plotted against the appropriate reduced motor start torque.
20. The pump manufacturer shall submit their requirements for pump exercising during extended periods when process operation is not required as described herein.
21. Installation and start-up report for each pump.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. OSHA, Occupational Safety and Health Act.

4. ANSI, American National Standards Institute.
5. ASTM, American Society for Testing Materials.
6. AISI, American Iron and Steel Institute.
7. HI, Hydraulic Institute Standards.
8. ABMA, American Bearing Manufacturer's Association.
9. NFPA, National Fire protection Association.

B. Experience: Equipment furnished under this Section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have a demonstrated record of successful operation of furnished equipment for a minimum period of 5 years, and a minimum of five similar applications. Provide a list of such installations complete with installation description, contact names, addresses, and telephone numbers. Contact information shall be up to date and current as of the date of bid opening. This reference list shall be submitted with the bid documents.

C. Single Source Responsibility: The pump supplier shall supply the following components and systems, and be responsible for the integration and proper system operation of these components:

1. Submersible (dry and wet pit) pumps.
2. Variable Frequency Drives.
3. Power and signal cables from motors to the first junction box.
4. Power and signal cable handling, support and storage systems.
5. Pump control and monitoring system.
6. Pump base, guide rail support brackets and other ancillary items

D. The Variable Frequency Drives shall be supplied by the pump supplier. The units shall comply with the Specification Section 16489 and the electrical drawings showing these units.

1.04 QUALITY STANDARDS

A. All submersible pumps specified in this Section shall be furnished by a single supplier who shall assume sole responsibility for providing a complete, operating system designed for long life with minimum required maintenance, meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these Specifications include:

1. ITT Flygt Corporation.
2. KSB
3. Or Equal

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 STORAGE AND PROTECTION

A. Pumps and accessories shall be stored and protected in accordance with the requirements of the General Conditions of the Contract Documents and manufacturer's recommendations.

B. Pump suction and discharge ports shall be provided with plugs or wooden bolted blind flanges. Each pump shall be secured to a wooden skid to facilitate handling and storage.

PART 2 - PRODUCTS

2.01 GENERAL

A. Pumps shall be of the heavy duty, submersible, centrifugal non-clog type and shall be supplied with motor, discharge elbow or support base, guide bar system and accessories. Guide wires are not acceptable in lieu of guide bars.

B. Pumps shall be suitable for pumping raw sewage and/or stormwater containing solids consisting of grit and organic materials and small quantities of petroleum products and greases, and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40° to 104° F. The pumps supplied under this specification shall be suitable for continuous operation under submerged or partially submerged conditions. Without derating the motor, the pumps shall be able to pump continuously with the minimum water level at the bottom of the motor housing, under full load, without the need of spray system or air moving equipment.

C. Dry pit pumps shall be capable of operating in a continuous non submerged condition in vertical position in a dry pit installation and permanently connected to inlet and outlet pipes. Pump shall be of submersible construction and will continue to operate satisfactorily should the dry pit be subjected to flooding.

D. Pumps installed in wet pit locations shall be automatically and firmly connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fasteners to be removed for this purpose and no need for personnel to enter the pump wet well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided to and pressed tightly against the discharge elbow.

E. Wet pit pumps and appurtenances, including the pump, motor, guide system, monitoring devices and wiring, shall be suitable for operation in the state of Georgia for explosion proof service. Pumps and appurtenances, including the pump, motor, guide system and wiring shall be approved by a national approved testing agency for installation in the state of Georgia for explosion proof service. The system shall be rated for Class 1, Division 1, Group D service as determined by the National Electrical Code and approved by a nationally recognized testing agency (U.L. or F.M.) at the time of bidding of this Project.

2.02 OPERATING CONDITIONS

A. Refer to the Contract Drawings for general arrangements and dimensional limitations. Provide complete submersible pump units designed for the indicated service and free of excessive vibration or hydraulic instability from minimum TDH to shutoff head when operating continuously or intermittently under the conditions herein specified.

B. The operating range of the pump shall include the duty points and shut-off head conditions. The pumps shall be non-overloading throughout the entire pump operating range.

C. All operating points listed in the performance tables below, with the exception of the shut-off head condition shall be located within the preferred operating region of pumps as established by pump manufacturer in accordance with ANSI/HI 9.6.3 and as published in the manufacturer's application data for the specific pump model being proposed for this application.

Parameter	Value	Value
Description	Diversion Pumps	Equalized Flow Return Pumps
Installation Type	Wet Pit	Dry Pit
No. of Pumps (total)	6	3
Equipment Tag Numbers	P-201, P-202, P-203, P-301, P-302, P-303	P-531, P-532, P-533
Service	Raw Sewage	Raw Sewage
Min. Shutoff Head, Ft.	140	140
Solids Handling Capacity, in	4	3
Discharge Connection Size, in	16	14
Suction Connection Size, in	N/A	16
Max. Pump Speed, rpm	1200	1200
Motor Horsepower Rating, Max.	335	215
Min. Motor Efficiency – full load / 50% load	94/92.5	93.5/93
Power Requirements	480V, 3-phase, 60 Hz	480V, 3-phase, 60 Hz
Electrical Classification	Class 1 Div.1	Class 1 Div. 2
Type of Drive	Variable Frequency	Variable Frequency
Pump Mfg./Model No. or equal	FLYGT N3400/835	FLYGT N3356/735
Hydraulic Conditions		
Design Point		
Flow, gpm / MGD	9300/13.4	7000/10
TDH, ft	98	90
Static Head, ft	75	64
Minimum Efficiency, %	75	80
Minimum NPSHa , ft	30	28
Minimum Head Condition		
Nominal Flow, gpm	6600	4000
TDH, ft	17 (15 feet from pressure control valve)	30
Static Head, ft	2	25
Minimum Efficiency, %	60	75
Minimum NPSHa , ft	30	45
Pump Operating Condition	Variable Speed – ~30 Hz	Variable Speed – ~30 Hz
Maximum Head Condition		
Nominal Flow, gpm	5000	3000
TDH, ft	115	110
Static Head, ft	80	65
Minimum Efficiency, %	55	50
Minimum NPSHa , ft	30	28
Pump Operating Condition	Synchronous Speed	Synchronous Speed

2.03 MATERIALS AND CONSTRUCTION

A. Pump Construction

1. All major parts (except for the impeller), such as the stator casing, oil casing, sliding bracket and discharge base assembly connection shall be of ASTM A-48 Class 35 minimum gray iron. All exposed bolts and nuts shall be 316 stainless steel. All mating surfaces of major parts shall be machined and fitted with rubber O-ring seals where watertight sealing is required, except at discharge elbow connection for wet pit pumps. O-rings shall be of materials suitable for use with and in raw sewage environment. All parts shall be interchangeable and watertight sealing shall not require additional machining of replacement parts, sealing compounds, or the application of specific torques to connectors.

2. All parts exposed to abrasive wear, other than volute and impeller, shall have a minimum Brinell hardness of 200.

3. In wet pit installations, no portion of the pump unit shall bear directly on the floor of the sump. There shall be no more than one 90-degree bend allowed between the volute discharge flange and the station piping.

4. A spark proof guide system shall be an integral part of the wet pit pump unit. The volute casing shall have a discharge flange and sliding bracket to automatically and firmly connect with the discharge connection, which when bolted to the floor of the sump and discharge line, will receive the pump discharge connecting flange without the need of adjustment, fasteners, clamps or similar devices. The guide system shall be certified by Factory Mutual (FM) to be suitable for Class 1, Division 1, groups C &D environments, when the discharge elbow is not submerged.

5. Provide an ASTM A-48 Class 35 cast iron discharge base assembly for wet pit pumps including a 90 degree elbow as indicated and base to support the entire weight of the pump and motor and to secure the lower end of the guide rails. Provide base with 125-lb ANSI B16.1 flange discharging vertically as indicated. Base shall be machined to receive sliding bracket of pump discharge.

6. Dry pit pumps shall be provided with a cast iron or fabricated steel support base for installation on the concrete foundations as shown on the drawings. Base shall be designed for the maximum possible loads of the pumps provided.

B. Impeller

1. The impeller shall be a high chrome casting per ASTM A-532 with a minimum hardness of 55 HRC, of non-clogging design, capable of handling solids, fibrous material, heavy sludge and other matter found in normal sewage applications. The casting shall have smooth surfaces devoid of blow holes or other irregularities. The impeller shall be constructed with a long throughlet without acute turns. The impeller shall be dynamically balanced. Static and dynamic balancing operations shall not deform or weaken it.

C. Pump Shaft: Pump and motor shaft shall be a solid continuous shaft. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The pump shaft shall be of ASTM A276, type 420 or AISI 431 stainless steel and shall be completely isolated from the pumped liquid by ASTM A 276, type 420 SS sleeve. The shaft shall be of sufficient section to limit the deflection at the shaft seal to not more than 1.5 mils when operating at any continuous duty point defined in the operating conditions. Provide calculations to document that the shaft

thickness design meets the deflection requirements. Calculations shall be sealed by a Professional Engineer licensed in the state of Georgia.

D. Volute

1. Pump volutes shall be single-piece gray cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller. The casting shall have smooth surfaces devoid of blow holes or other irregularities. Minimum inlet and discharge size shall be as specified.

2. The pump volute shall be coated on the inside surface with tungsten carbide applied with an HVOF process to provide maximum density and strength. The hardness of the coating shall be 60 HRC minimum. Coating shall have a thickness of .005 to .015 inch.

E. Mechanical Seal

1. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The lower seal shall be independent of the impeller hub. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating corrosion resistant silicon-carbide seal ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating corrosion resistant silicon-carbide seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal.

2. Should both seals fail and allow fluid to enter the stator housing, a port shall be provided to direct that fluid immediately to the stator float switch to shut down the pump and activate an alarm. Any intrusion of fluid shall not come into contact with the lower bearings.

3. The following seal types shall not be considered acceptable or equal to the dual independent seal specified: Shaft seals without positively driven rotating members, or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces. No system requiring a pressure differential to offset pressure and to affect sealing shall be used.

4. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication.

F. Guide Bars System

1. Stainless steel guide bars shall be provided as shown on the Drawings and shall be 3-inch diameter, Schedule 40 316L stainless steel pipes attached to the automatic discharge connection at the lower end and to an upper guide bar bracket at the upper end. Intermediate guide bar supports shall be provided as shown on the Drawings and as required to ensure a secure installation. Two guide bars shall be provided for each pump. Guide bars shall not support any of the weight of the pump. Guide bars, upper and intermediate supports, and

anchor bolts shall be provided by the Contractor. All guide bar support components shall be of 316 SS. Cable type guide systems shall not be acceptable.

2. Pump guide rails and supports shall be designed to be adequate to withstand forces associated with pump installation and operation.

G. Additional Accessories: Suction flow vanes shall be provided for all pumps where shown on the Drawings. The pump manufacturer shall review the location and dimensions of flow vanes as shown on Drawings and shall recommend changes as required to improve the hydraulics of flow entry into pumps. Flow vanes may be omitted based on pump manufacturer's recommendation.

2.04 MOTOR

A. Pump Motor

1. Pump motors shall be designed in accordance with the standards of NEMA. Refer to paragraph 2.02 of the Specification for additional pump characteristics. Motors shall be suitable for operation in hazardous areas as specified above provided the provisions of 2.01 D are met. The motor and the pump shall be produced by the same supplier. Motors shall also meet the additional requirements as specified in Section 16150.

2. The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The motor shall be able to operate continuously while non-submerged without damage while pumping under load.

3. The stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the Vacuum Pressure Impregnation (VPI) or trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.

4. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.

5. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable.

6. The motor shall be specifically designed for submersible pump usage and designed for continuous duty pumping media of up to 40°C (104°F) with an 80°C temperature rise and capable of at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum.

7. Ambient compensated RTDs, PT100 shall be embedded in the stator end turns in each phase to monitor the temperature of each phase winding. These ambient compensated RTDs shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.

8. An ambient compensated RTD type temperature sensor shall be provided for the lower (main) bearing. The sensor shall directly contact the outer race of the thrust bearing providing for accurate temperature monitoring.

9. A leakage sensor shall be provided to detect water in the stator chamber. The Float Leakage Sensor (FLS), a small float switch, shall be used to detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and activate an alarm.

10. Vibration sensors shall be provided in the pumps.

11. The stator RTDs, temperature switches, FLS, vibration sensors and the lower bearing RTD for each pump shall all be connected to the pump monitoring unit for that pump. Provide individual pump monitoring units for each pump to be mounted as shown on the Drawings.

12. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and control cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable.

13. A leakage sensor shall be provided to detect water in the junction box.

14. A leakage sensor shall be provided to detect water in the inspection chamber.

15. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15 except motors for inverter duty that shall have a service factor of 1.0. The motor shall have a voltage tolerance of plus or minus 10%.

16. A performance chart shall be provided showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

17. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from run-out condition through shut-off.

18. Any additional alarm or control device, including wiring, conduit, controls, etc., which the pump supplier recommends or requires for warranty, shall be furnished by the Contractor at no additional cost to the City.

19. The Contractor shall adhere strictly to the manufacturer recommended installation procedure and wiring requirements for pump control units.

B. Bearings

1. The pump shaft shall rotate on at least three sealed grease-lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearings shall consist of at least one roller bearing for radial forces and one or two angular contact ball bearings for axial thrust. Upper bearing outer races shall be insulated from the housing to prevent flow of circulating currents caused by VFD operation of pumps.

2. The minimum L10 bearing life shall be 100,000 hours for the Design Point condition specified in Par. 2.02.

C. Cooling System

1. Each pump/motor unit shall be provided with an integral, self-priming and self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A-48, Class 35B.

2. The water jacket shall provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. The impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the pumpage, through the cooling system.

3. Two cooling liquid supply pipes, one discharging low and one discharging high within the jacket, shall supply the cooling liquid to the jacket. An air evacuation tube shall be included to provide automatic air removal from within the jacket. Any piping internal to the cooling system shall be shielded from the cooling media flow allowing for unobstructed circular

flow within the jacket about the stator housing. Two cooling liquid return ports shall be provided.

4. The internals to the cooling system shall be non-clogging by virtue of their design.
5. The cooling jacket shall be equipped with two flanged and bolted inspection ports of not less than 4"Ø located 180° apart. The inspection port shall be sealed with an O-ring seal. No gaskets shall be allowed.
6. The cooling system shall provide for continuous submerged or completely non-submerged pump operation in liquid or in air having a temperature of up to 40°C (104°F), in accordance with NEMA standards. Restrictions limiting the ambient or liquid temperatures at levels less than 40°C are not acceptable.
7. Cooling water may be required for the Equalized Flow Return Pumps P-531/532/533 due to the low speed operation of the pumps under some conditions. The pump manufacturer shall provide a complete cooling water system with flow meter, solenoid valve, pressure regulator, loss of flow indicator and any other components required for the cooling water supply. Cool water system shall operate from the city water supply but downstream of the backflow preventer. The cooling water will be piped into the cooling jacket and discharge into the pump volute.

D. Cables

1. Power and control cables shall be suitable for submersible pump applications and shall be indicated by a code or legend permanently embossed on the cable.
2. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber. Power cable shall be similar as vertical riser cable with messenger wires attached to it. Messenger wires shall be of adequate length and shall be supported from top of pump station. Power cable for VFD driven pumps shall be approved by the VFD Manufacturer.
3. The motor control cable shall be designed specifically for use with submersible pumps and shall be equal to SUBCAB (Submersible Cable). The cable shall be shielded, multi-conductor type with a chloroprene outer jacket and the tinned copper conductors insulated with ethylene-propylene rubber. The conductors shall be arranged in twisted pairs. The cable shall be rated for 750 Volts and 90°C (194°F) with a 40°C (104°F) ambient temperature and shall be approved by Factory Mutual (FM). The cable length shall be adequate to reach the junction box without the need for splices.
4. The cable entry sealing fitting shall relieve stress on conductors and provide a watertight and submersible seal, without the use of sealing compounds and without the application of specific torques to connectors. The conductors shall connect to a terminal board, which shall be provided with a moisture tight seal between the cable entry junction chamber and the motor.
5. The cable entry water seal design shall preclude specific torque requirements to ensure a watertight and submersible seal. The cable entry shall be comprised of a dual cylindrical elastomeric grommet, flanked by stainless steel washers all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the entry body containing a strain relief function, separate from the function of sealing the cable. The assembly shall bear against a shoulder. The cable entry junction chamber and motor shall be

separated by a stator leading sealing gland or terminal board, which shall isolate the motor interior from foreign material gaining access through the pump top.

6. Power and Control Cable Protection System: The pump supplier shall provide a support and protection system for the power and control cables for each of the pumps supplied. This system shall be a part of, and integrated into each pump unit. The supplier shall assume full responsibility for its function and provide a functional guarantee, as detailed below. The system shall consist of the following components and functions:
   a. The pump supplier shall guarantee that this system functions in an automatic and effortless way while a pump is lifted or installed, that no wear, tear or damage be inflicted to either of the flexible electrical cables. Any cable wear or operational problems that occur within a 5-year period shall be repaired and improved by the pump supplier without cost to the Owner.
   b. Appropriate cable support brackets shall be supplied by the pump supplier and permanently installed by the contractor at the deck level to provide support and strain relief function. These brackets shall be capable of supporting the entire length of cables contained within the wet-well, with a safety margin of no less than 3.5. The cable support brackets shall be fabricated from 316 stainless steel plates and shall be specifically designed to support the cables. Pump manufacturer shall coordinate brackets details with those shown on the drawings and finalize dimension and spacing of brackets. All edges of the bracket that come in contact with the cables shall be rounded and ground smooth to avoid any damage to the cables.

2.05 CONTROLS

A. Variable Frequency Drives for the variable speed pumps shall be furnished by the pump supplier. The pump supplier shall be responsible for coordinating with the drive manufacturer to verify that the current rating of the drives is suitable for all flow and head conditions. Pump supplier shall also ensure that the drive will be satisfactory for accelerating the motor. Variable frequency drives shall be in accordance with the Electrical Drawings and specifications.

B. Control of pumps shall be provided for under Division 13 and as specified under Article 2.04.

C. Pump Monitoring and Control System

1. The pump supplier shall supply an integrated pump monitoring and control system, containing the following sensors (indicated quantities are per pump), components and functions:
   a. Stator winding temperature sensor (platinum RTD) x 3 (one per motor phase).
   b. Stator housing leakage (ball float switch).
   c. Motor temperature switch (PTC) for each phase.
   d. Support bearing temperature (platinum RTD)
   e. Motor junction box leakage (ball float switch).
   f. Main bearing temperature (platinum RTD).
   g. Pump vibration sensor (2 axis vibration with velocity readout).
   h. Pump electronic ID module with runtime and start counters.
   i. Shielded flexible submersible signal cable from pump to first junction box.
   j. Control panel mounted monitoring and status unit with inputs for the above sensor signals. This unit shall be powered by 120VAC and contain user settable warning and

shutdown alarm levels for each sensor input. A "long lead" temperature compensation function shall be provided for all RTD inputs. The device shall have an embedded web-server and all settings shall be accessible via Microsoft Internet Explorer either locally or remotely. The device shall be "provided" with communication via RS 232 and RS 485 ports as well as Modbus protocols to higher level SCADA systems.

k. Each pump shall be equipped with a pump monitoring and control system unit and a panel mounted remote user display (a local input/output device).

l. The pump monitoring and control system shall be MAS unit as manufactured by ITT FLYGT or Equal.

D. Provide individual monitoring and control unit for each pump. Provide control panels in individual enclosures for each monitoring and control unit. Each unit shall be provided with 120V power from the respective pump VFD or RVSS. Control panel shall be provided with required DC power supply. Monitoring and control units shall provide required RS 485 connections to the DCS system and interlock to the VFD or RVSS.

2.06 SPECIAL OPERATING CONDITIONS

A. The pumping systems may not be required to operate to meet the process requirements for extended periods of up to several months when there is no flow into the pump station. The manufacturer shall consider these conditions and specify any special maintenance requirements necessary to guarantee the long term operability of the equipment. It is anticipated that during the extended periods of inactivity, the pumps will be cycled or "bumped" for short periods for maintenance purposes. This process will occur "dry" with no water in the wet well. The pump manufacturer shall specify the frequency and duration required for each pump cycle for each set of pumps. These settings will be included in the main control system. The manufacturer shall also include any other special maintenance requirements for their equipment to meet these conditions. This information will be submitted with the shop drawings as specified above.

2.07 FACTORY INSPECTION AND TESTING

A. The pump supplier shall conduct full scale, full range factory performance tests as specified herein. The Engineer shall witness the pump tests and certified test reports shall be submitted for approval, prior to shipment of the pumps. Tests shall be conducted in accordance with the latest edition of the Submersible Pump Test Standard, ANSI/HI 11.6

B. The Contractor shall provide for witnessing of the factory performance testing by three representatives of the Owner, and shall provide all transportation (economy class), lodging, meals and miscellaneous expenses necessary for the Owner's representatives to attend the factory performance tests. Factory testing shall be conducted at a location to be determined by the pump manufacturer within the continental US.

C. Each pump shall be tested for performance at the factory as specified herein.

D. Testing shall include but not limited to the following:

1. Impeller, motor rating and electrical connections shall first be checked for compliance to specific requirements. Impeller shall be visually inspected to certify that it is free of defects.
2. Conduct mechanical and electrical motor integrity tests in accordance with ANSI/HI 11.6.
3. Motor and cable insulation test for moisture content or insulation defects.

4. After a submerged test run of 30 minutes, item 2 shall be retested.
5. If any deviation of above is found, the pump shall be rejected.

E. Pump Tests

1. Hydrostatically test each pump casing under a hydrostatic head of 100 psig or 150 percent of rated shutoff head, whichever is greater. Tests shall be performed using the complete pump system to be furnished, including the Project motor and variable speed drive for units supplied with variable speed drives. Testing of prototype models will not be acceptable.
2. All tests, including the $NPSH_R$ tests shall be in accordance with ANSI/HI 11.6. Required test acceptance level shall be ANSI/HI Acceptance Level: A.

F. Testing

1. Run pump at full speed rating point for 60 minutes prior to start of any testing.
2. Full Speed Tests: Test pump at the specified conditions and record and tabulate readings of flow, differential pressure, BHP, efficiency, $NPSH_R$, input kW, voltage, frequency, and power factor for each test point.
3. At a minimum, tests shall be carried out at each of the operating points listed in Article 2.02 including the Design Point, Minimum Flow/Maximum Head Point and Maximum Flow Minimum Head Point.
4. Operate each pump for not less than one hour and take readings to verify that the pump will operate as specified without cavitation or excessive vibration and with no more than the specified NPSHA, where such is stated.
5. Run each pump at minimum speed rating point for 6 hours.
6. Run a test with each pump operating with its minimum recommended submergence.
7. Testing of pumps at specified points shall be accomplished with the pumps submerged for wet pit pumps.
8. In the event that specified tests indicates that a pump or motor does not meet specifications, The Owner reserves the right to require witnessed re-testing tests for that pump and motor at no additional cost to the Owner.
9. Furnish certified performance tests as specified for all pumps.
10. Furnish a certification that the pump horsepower demand did not exceed the rated motor horsepower beyond a 1.0 service rating at any of the test points.

2.08 FACTORY PAINTING

A. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied coating in accordance with Specification Section 09900.

B. The pump manufacturer shall provide extra finish coat similar to the factory applied finish coating for Contractor touch up painting in the field.

2.09 SPARE PARTS

A. The pump supplier shall provide a list of recommended spare parts and shall indicate what items are stocked and which items are special orders. The spare part list below shall be supplied with the pumps at a minimum.

Item	Qty. for each pump set
Bearing set	1
O-ring service set	2
Pump Monitoring and Control System	1

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment Installation: All equipment shall be installed in accordance with approved shop drawings and manufacturer's recommendations.

B. Anchorage: Stainless steel anchor bolts, nuts and washers, as well as any templates necessary for setting the anchorage, shall be furnished by the equipment manufacturer. Placement of the anchor bolts shall be done by the Contractor from certified dimension shop drawings supplied by the equipment manufacturer.

C. Leveling and Grouting

1. Level and align pump and guide bars in accordance with the respective manufacturer's published data.
2. Grout pump mounting base as required with non-shrink grout in accordance with the ACI, equipment manufacturer's and grout manufacturer's published specifications.

3.02 PAINTING

A. After installation and approved field testing by the Engineer, the Contractor shall apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.03 MANUFACTURER SERVICES

A. Furnish the services of trained service technician, certified by the manufacturer, to service the type of equipment specified in accordance with the requirements of the General Conditions of the Contract Documents and as specified herein.

B. The service representative must have a minimum of five years of experience, all within the last seven years, supervising the installation and inspection of the type and size of equipment specified.

C. The service representative must be present on site for all items listed below. Work-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

D. Provide assistance to the Contractor during equipment installation including, but not limited to observation, guidance, instruction of contractor's assembly, erection, installation or application procedures, inspection and checking of installation and furnishing of written approval of installation.

1. 6 work-days over a minimum of two trips.

E. Assistance during functional and performance testing and startup demonstration, and product acceptance by the Owner.

1. 7 work-days over a minimum of two trips.

F. Training of Owner's personnel in the operation and maintenance of equipment as required. Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom session.

1. 1 work-day.

G. For the purposes of this paragraph, a work day is defined as an eight hour period at the Project site, excluding travel time. The Engineer may request that a work day be furnished in a maximum of two trips. All unused work days shall be credited to the Owner at the manufacturer's published field service rate.

H. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.04 FIELD TESTING

A. The Contractor shall obtain water for field testing of pumps from a source approved by the Owner. The Contractor shall be responsible, at no additional cost to the Owner for provision of temporary piping, pumping, and other ancillary equipment necessary for delivery of water to the pump station for pump testing purposes. Test water shall be disposed of as directed by the Owner.

B. Contractor shall provide all labor, piping, equipment, portable flow meters, calibrated gauges or calibrated test gauges, and materials for conducting tests. Tests will not be acceptable if equipment calibration is not within 60 days of the field testing.

C. The pumps shall be tested at start-up by the pump supplier or its authorized representative. The pump supplier shall provide a formal test procedure and forms for recording the test data. The person designated and provided by the manufacturer for start-up services shall be authorized by U.L or F.M. for the service.

D. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, damaging cavitation, or overheating of bearings and to demonstrate the indicated head, flow, and efficiency at the design rating point.

E. Test removal and replacement of all pumps to prove the pumps and guiderail systems are properly installed and aligned using the bridge crane installed under Section 14600.

F. Pump control devices including but not limited to pump start delay timers, vibration monitors/switches, etc shall be tested and adjusted in the field by the manufacturer service representative.

G. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's service representative, conduct running test for each pump in presence of the Engineer to determine its ability to deliver its rated capacity under specified conditions.

1. Field testing shall not be conducted without an approved procedure and calibration certificates for all testing equipment, gauges and flow meters.
2. Contractor shall provide, operate and maintain temporary pumps, piping, gauges and other components necessary to recirculate water from the pump station to the diversion structure or pump station inlet chamber for recycle throughout the testing period.
3. Startup, check and operate each pump system over its entire range of operation. For pumps controlled with variable speed drives, increase the speed range at 100 RPM increments. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the Engineer.
4. During tests, observe and record speed/frequency, head, capacity and input kW. Calculate BHP and efficiency for each observation.
5. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
6. Submit a table of results with a listing of a minimum of 10 test points throughout the pump range including rating points through shut-off head.

3.05 SERVICE CAPABILITY

A. Service Facility and Maintenance Agreement

1. The pump supplier shall have a service and repair facility, equipped with proper tools and lifting equipment that is owned and operated by the pump supplier, within a 50-mile radius of the pump station. This facility shall have been in operation for a minimum of 10-years, and shall be staffed with factory certified maintenance personnel. The facility shall have F.M. certified mechanics on staff for servicing of explosion proof pumps. This facility shall be available for inspection by the Engineer during any working hour of a normal business day.
2. The facility shall stock complete sets of seals, bearings, O-rings and wear rings for each pump model to enable a maximum of 72-hour repair after receipt of pump for maintenance or repair.
3. The facility shall have U.L. or F.M. certified mechanics on staff to service the pumps.
4. A scheduled 5-year preventative maintenance and service agreement shall be included in the manufacturer's price with the supply of pumps. Each pump shall be inspected once per year, or every 5,000 hours, whichever comes first. The inspection shall consist of a complete and thorough 20 point mechanical and electrical check of each pump followed by a complete report of the findings. This agreement includes all labor and fluids and grease used for the inspections outlined by the maintenance agreement for each of the pumps for the full 5-year period and assures that all requirements for fulfillment of the pump warranty have been met.

5. The pump supplier shall be responsible for raising the pumps from the wet well; servicing the pumps on the pump station top deck and lowering the pumps back down into the wet well as required for the inspections.

END OF SECTION 11199

SECTION 11200
CHOPPER PUMPS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of all chopper pumps and accessories for installation submerged in the Diversion Pump Station wet well and exposed in the Jet Mix Building pump room. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Section 09900 - Painting.
2. Section 15060 - Piping and Appurtenances
3. Section 15100 - Valves and Piping Appurtenances
4. Division 13 - Instrumentation and Control
5. Division 16 - Electrical

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's data: Dimensions; materials of construction; size and location of anchor bolts, pump base and guide rails, support frame, etc. Provide details of all pump protective control devices, leakage sensors, bearing temperature sensors, motor temperature sensors, etc. to define all components to be included.
2. Data, regarding pump and motor characteristics and performance including:
   a. Guaranteed performance curves (prior to fabrication and testing) based on actual shop tests of mechanically similar pumps, showing they meet specified requirements for head, capacity, horsepower, efficiency and NPSHR.
   b. Provide catalog performance curves at required speed showing maximum and minimum impeller diameters available.
3. Submit curves for guaranteed performance and certified test on 8-1/2-in. by 11-in. sheets, one curve per sheet.

4. Certified results of hydrostatic testing and dynamic balancing.
5. Complete wiring and control diagrams, wiring sizes and wiring specifications.
6. List of recommended spare parts, including those specified herein.
7. Location of nearest authorized pump service center.
8. Recommendations for short and long-term storage.
9. Manufacturer's Certifications.
10. Factory testing procedures, sketch of test setup and results of certified performance testing.
11. Field testing procedures, equipment to be used and calibration certificates. Submit a minimum of two (2) weeks prior to field testing.
12. The pump manufacturer shall submit their requirements for pump exercising during extended periods when process operation is not required as described herein.

B. Submit manufacturer's Installation and Start-up Report upon completion of start-up services.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal, State, and local laws and regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ACI, American Concrete Institue
6. ASTM, American Society for Testing Materials.
7. AISI, American Iron and Steel Institute.
8. HI, Hydraulic Institute Standards.
9. ABMA, American Bearing Manufacturer's Association.
10. NFPA, National Fire protection Association.

B. Experience: Equipment furnished under this Section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have a demonstrated record of successful operation of furnished equipment for a minimum period of five (5) years, and a minimum of five (5) similar applications. Provide a list of such installations complete with installation description, contact names, addresses, and telephone numbers. Contact information shall be up to date and current as of the date of bid opening.

1.04 QUALITY STANDARDS

A. All chopper pumps specified in this Section shall be furnished by a single supplier who shall assume sole responsibility for providing a complete, operating systems designed for long life with minimum required maintenance, meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these Specifications include:

1. Vaughan Corporation.
2. Or Equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 STORAGE AND PROTECTION

A. Pumps and accessories shall be stored and protected in accordance with the requirements of the General Conditions of the Contract Documents and manufacturer's recommendations.

B. Pump suction and discharge ports shall be provided with plugs or wooden bolted blind flanges. Each pump shall be secured to a wooden skid to facilitate handling and storage.

PART 2 - PRODUCTS

2.01 GENERAL

A. Submersible Chopper Pumps.

1. The submersible chopper pump shall be specifically designed to pump waste solids at heavy consistencies without plugging or dewatering of the solids. Materials shall be chopped/macerated and conditioned by the pump as an integral part of the pumping action.
2. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications. The pumps supplied under this specification shall be suitable for continuous operation under submerged or partially submerged conditions. Without de-rating the motor, the pumps shall be able to pump continuously with the minimum water level at the bottom of the motor housing, under full load, without the need of spray system or air moving equipment.
3. The pumps shall be automatically and firmly connected to the discharge connection elbow when lowered into place. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fasteners to be removed for this purpose and no need for personnel to enter the pump wet well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple downward motion of the pump with the entire weight of the pumping unit guided to and pressed tightly against the discharge elbow.

4. Pumps and appurtenances, including the pump, motor, guide system and wiring, shall be suitable for operation in the state of Georgia for explosion proof service. Pumps and appurtenances, including the pump, motor, guide system, and wiring shall be approved by a national approved testing agency for installation in the state of Georgia for explosion proof service. The system shall be rated for Class 1, Division 1, Group D service as determined by the National Electrical Code and approved by a nationally recognized testing agency (U.L. or F.M.) at the time of bidding of this Project.

B. Dry Pit Chopper Pumps.

1. The pump shall be specifically designed to pump waste solids at heavy consistencies. Materials shall be macerated and conditioned by the pump as an integral part of the pumping action.
2. The pump must have demonstrated the ability to chop through, mix and pump high concentrations of solids such as plastics, heavy rags, grease and hair balls, wood, paper products and stringy materials without plugging, both in tests and field applications.
3. The dry pit pumps shall be vertical, pedestal mounted or provided with a support frame. Standard TEFC motors will be supplied for dry pit pumps.

2.02 OPERATING CONDITIONS

A. Submersible Chopper Pumps.

1. Refer to the Contract Drawings for general arrangements and dimensional limitations. Provide complete submersible pump units designed for the indicated service and free of excessive vibration or hydraulic instability from minimum TDH to shutoff head when operating continuously or intermittently under the conditions herein specified.
2. The operating range of the pump shall include the duty points and shut-off head conditions. The pumps shall be non-overloading throughout the entire acceptable pump operating range.
3. All operating points listed in the performance table below, with the exception of the shut-off head condition shall be located within the preferred operating region of the pump as established by pump manufacturer in accordance with ANSI/HI 9.6.3 and as published in the manufacturer's application data for the specific pump model being proposed.

PUMP PERFORMANCE TABLE – Submersible Chopper Pumps	
Parameter	Value
Description	Diversion Pump Station Wet Well Drainage Pumps
No. of Pumps (total)	2
Equipment Tag Numbers	P-204, P-304
Service	Raw Sewage
Fluid Temperature	Ambient
Min. Shutoff Head, Ft.	43
Discharge Connection Size, in	3
Max. Pump Speed, rpm	1750
Motor Horsepower Rating, Max.	5
Power Requirements	480V, 3-phase
Type of Drive	Synchronous Speed
Pump Mfg./Model No. or equal	Vaughan SE3G-060
Hydraulic Conditions	
Design Point	
Flow, gpm	300
TDH, ft	26.5
Static Head, ft	19
Minimum Efficiency, %	45
Minimum NPSHa , ft	30
Maximum Flow/Minimum Head Condition	
Flow, gpm / MGD	440
TDH, ft	13.1
Minimum NPSHa , ft	30
Minimum Flow/Maximum Head Condition	
Flow, gpm / MGD	200
TDH, ft	33.2
Minimum NPSHa , ft	30

B. Dry Pit Chopper Pumps.

1. Refer to the Contract Drawings for general arrangements and dimensional limitations. Provide complete dry pit pump units designed for the indicated service and free of excessive vibration or hydraulic instability from minimum TDH to shutoff head when operating continuously or intermittently under the conditions herein specified.
2. The operating range of the pump shall include the duty points and shut-off head conditions. The pumps shall be non-overloading throughout the entire acceptable pump operating range.
3. All operating points listed in the performance table below, with the exception of the shut-off head condition shall be located within the preferred operating region of the pump as established by pump manufacturer in accordance with ANSI/HI 9.6.3 and as published in the manufacturer's application data for the specific pump model being proposed.

PUMP PERFORMANCE TABLE – Dry Pit Chopper Pumps	
Parameter	Value
Description	Equalization Drainage Pumps
No. of Pumps (total)	2
Equipment Tag Numbers	P-534, P-535
Service	Raw Sewage
Fluid Temperature	Ambient
Min. Shutoff Head, Ft.	150
Discharge Connection Size, in	4
Max. Pump Speed, rpm	1800
Motor Horsepower Rating, Max.	50
Power Requirements	480V, 3-phase
Type of Drive	Synchronous Speed
Pump Mfg./Model No. or equal	Vaughan PE4P6
Hydraulic Conditions	
Design Point	
Flow, gpm	750
TDH, ft	107.5
Static Head, ft	80
Minimum Efficiency, %	55
Minimum NPSHa , ft	26
Maximum Flow/Minimum Head Condition	
Flow, gpm / MGD	1100
TDH, ft	87
Minimum NPSHa , ft	25
Minimum Flow/Maximum Head Condition	
Flow, gpm / MGD	400
TDH, ft	125
Minimum NPSHa , ft	30

2.03 MATERIALS AND CONSTRUCTION

A. Submersible Chopper Pumps.

1. Pump Construction
   a. Casing and Back Pull-Out Plate: The pump casing shall be of volute design, spiraling outward to the flanged centerline discharge. Back pull-out design shall incorporate jacking bolts for accurate adjustment of impeller-to-cutter bar clearance. Casing & backplate shall be ductile iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. Backplate shall include a replaceable Rockwell C 60 steel cutter adjustable for 0.005-0.015" clearance to cut against the rotating impeller pumpout vanes for removing fiber and debris.
   b. No portion of the pump unit shall bear directly on the floor of the sump. There shall be no more than one 90-degree bend allowed between the volute discharge flange and the station piping.
   c. A spark proof guide system shall be an integral part of the pump unit. The volute casing shall have a discharge flange and sliding bracket to automatically and firmly connect with the discharge connection, which when bolted to the floor of the sump and

discharge line, will receive the pump discharge connecting flange without the need of adjustment, fasteners, clamps or similar devices. The guide system shall be certified by Factory Mutual (FM) to be suitable for Class 1, Division 1, groups C &D environments, when the discharge elbow is not submerged.

d. Provide an ASTM A-48 Class 35 cast iron discharge base assembly including a 90 degree elbow as indicated to support the entire weight of the pump and motor and to secure the lower end of the guide rails.

e. Provide base with 125-lb ANSI B16.1 flange discharging vertically as indicated.

2. Impeller
   a. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a maximum set clearance between the impeller and cutter bar of 0.015-0.025" cold. Impeller shall be cast alloy steel heat treated to minimum Rockwell C 60 and dynamically balanced. The impeller shall be keyed to the shaft and shall have no axial adjustments and no set screws.

3. Pump shafting shall be heat-treated alloy steel.

4. Cutter Bar Plate: Shall be recessed into the pump bowl and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.010-0.020" of the rotating cutter nut tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Cutter bar shall be alloy steel heat-treated to minimum Rockwell C 60.

5. Cutter Nut: The impeller shall be secured to the shaft using a cutter nut, designed to cut stringy materials and prevent binding using a raised, rotating cutter tooth. The cutter nut shall be cast steel heat treated to minimum Rockwell C 60.

6. Upper Cutter: Shall be threaded into the back pull-out adapter plate behind the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel heat treated to minimum Rockwell C 60. The upper cutter teeth are positioned as closely as possible to the center of shaft rotation to minimize cutting torque and nuisance motor tripping. The ratio of upper cutter cutting diameter to shaft diameter in the upper cutter area of the pump shall be 3.0 or less.

7. Guide Bars System
   a. Stainless steel guide bars shall be provided as shown on the Drawings and shall be schedule 40, 316L stainless steel pipes attached to the discharge connection at the lower end and to an upper guide bar bracket at the upper end. Intermediate guide bar supports shall be provided at maximum 10 ft spacing. Two guide bars shall be provided for each pump. Guide bars shall not support any of the weight of the pump. Guide rail system shall be non-sparking.

   b. Pump guide rails and supports shall be designed to be adequate to withstand forces associated with pump installation and operation.

B. Dry Pit Chopper Pumps.

1. Casing and Back Pull-Out Adapter Plate: The pump casing shall be of semi-concentric design, with the first half of the circumference being cylindrical beginning after the pump outlet, and the remaining circumference spiraling outward to the 150 lb. flanged centerline

discharge. Back pull-out adapter plate shall allow removal of pump components from the casing, and allow external adjustment of impeller-to-cutter bar clearance. Casing and adapter plate shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics.

2. Impeller: Shall be semi-open type with pump out vanes to reduce seal area pressure. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of .010" to .015". Impeller shall be cast steel heat treated to minimum Rockwell C 60 and dynamically balanced. The impeller shall be keyed to the shaft and shall have no axial adjustments or set screws required. Open type impellers or impellers without pump out vanes shall not be allowed on this project.

3. Cutter Bar Plate: Shall be recessed into the pump bowl and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.010-0.015" of the rotating cutter nut tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Cutter bar shall be ASTM A 829, 8620 plate steel heat-treated to minimum Rockwell C 60. Pumps with bolt on cutter bar segments shall not be allowed on this project.

4. Cutter Nut: The impeller shall be secured to the shaft using a special cutter nut, designed to cut stringy materials and prevent binding. The cutter nut shall be cast steel heat treated to minimum Rockwell C 60. Nuts, bolts, or other impeller securing devices that lack the ability to cut debris from the pump suction shall not be allowed on this project.

5. Upper Cutter: Shall be threaded into the back pull-out adapter plate above the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. Upper cutter shall be cast steel heat treated to minimum Rockwell C 60. The upper cutter shall be a replaceable item and be separate from the casing back plate.

6. Pump Shafting: The pump shaft and impeller shall be supported by ball bearings. Shafting shall be heat treated steel, with a minimum diameter of 1.5 inches in order to minimize deflection during solids chopping.

7. Bearings: Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings. Two single-row radial bearings shall also be provided. Bearings shall provide a minimum B10 bearing life of 100,000 hours.

8. Bearing Housing: Shall be ductile cast iron, and machined with piloted bearing fits for concentricity of all components. Bearing housing shall have oil bath lubrication using ISO Gr 46 turbine oil with reservoir, to provide a permanently lubricated assembly. Viton® double lip seals riding on chromed stainless steel shaft sleeves are to provide sealing at each end of the bearing housing.

9. Flushless Mechanical Seal shall be required and be designed to require no seal flush through the elimination of the stuffing box. The seal shall be cartridge-type with Viton O-rings and silicon carbide faces. The cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required. Any springs used to push the seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a 17-4PH, heat-treated seal sleeve and an ductile iron or 316 SS seal gland. The mechanical seal faces shall be lubricated and cooled by a separate oil chamber.

10. The pump assembly shall be mounted vertically on a 90 degree forged steel elbow with 150 lb. standard inlet flange, cleanout and pedestal base. The pedestal base shall support the pump and drive motor.

11. Shaft Coupling: The bearing housing and motor stool design provides accurate, self-aligning mounting for a C-flanged electric motor. Alignment between pump and motor shafts shall be accomplished through the use of a T.B. Woods Sureflex elastomeric type coupling.

12. Stainless Steel Nameplates: Shall be attached to the pump and drive motor giving the manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.

2.04 MOTOR

A. Submersible Chopper Pump.

1. Submersible Electric Motor: Shall be U/L listed explosion proof for Class 1, Group D, Division 1 hazardous locations with a 1.15 service factor and Class F insulation. Motor shall be equipped with tandem independently mounted mechanical seals in oil bath and with dual moisture sensing probes. The inner and outer seals shall be separated by an oil-filled chamber. The oil chamber shall act as a barrier to trap moisture and provide sufficient time for a planned shutdown. The oil shall also provide lubrication to the internal seal. The inner seal shall be a standard UL listed John Crane Type 21 or equal, with carbon rotating faces and ceramic stationary faces. The outer seal construction shall be designed for easy replacement. Outer mechanical seal shall be 316 stainless steel metal bellows type with silicon carbide or tungsten carbide faces. Seal shall be positively driven by set screws. Elastomers shall be of Viton. Motor shall include two normally closed automatic resetting thermostats connected in series and imbedded in adjoining phases. Motor frame shall be cast iron, and all hardware and shaft shall be stainless steel.

2. Cables
   a. Power and control cables shall be suitable for submersible pump applications and shall be indicated by a code or legend permanently embossed on the cable.
   b. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber.

B. Dry Pit Chopper Pump.

1. Drive motor shall be 50 HP, 1800 RPM, 460 volts, 3 phase, 60 hertz, Premium Efficient, Severe Duty, 1.15 service factor, C-flange mounted, in a TEFC enclosure. The motor shall be sized for non-overloading conditions. See Section 16150 for additional motor requirements.

2.05 SPECIAL OPERATING CONDITIONS

The pumping systems may not be required to operate to meet the process requirements for extended periods of up to several months when there is no flow into the pump station. The manufacturer shall consider these conditions and specify any special maintenance requirements necessary to guarantee the long term operability of the equipment. It is anticipated that during the extended periods of inactivity, the pumps will be cycled or "bumped" for short periods for maintenance purposes. This process will occur "dry" with no water in the wet well. The pump manufacturer shall specify the frequency and duration required for each pump cycle for each set

of pumps. These settings will be included in the main control system. The manufacturer shall also include any other special maintenance requirements for their equipment to meet these conditions. This information will be submitted with the shop drawings as specified above.

2.06 FACTORY PAINTING

A. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied coating in accordance with Specification Section 09900.

B. The pump manufacturer shall provide extra finish coat similar to the factory applied finish coating for Contractor touch up painting in the field.

2.07 SPARE PARTS

A. The pump supplier shall provide a list of recommended spare parts and shall indicate what items are stocked and which items are special orders. The spare part list below shall be supplied at a minimum.

Item	Qty. for each pump set
Bearing set	1
Gasket or O-ring service set	2
Cutters and Cutter Bar Plate	2
Mechanical Seal Assembly	1

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment Installation: All equipment shall be installed in accordance with the approved shop drawings and manufacturer's recommendations.

B. Anchorage: Stainless steel anchor bolts, nuts and washers, as well as any templates necessary for setting the anchorage, shall be furnished by the equipment manufacturer. Placement of the anchor bolts shall be done by the Contractor from certified dimension shop drawings supplied by the equipment manufacturer.

C. Leveling and Grouting

1. Level and align pump and guide bars in accordance with the respective manufacturer's published data.
2. Grout pump mounting base as required with non-shrink grout in accordance with the ACI, equipment manufacturer's and grout manufacturer's published specifications.

3.02 FACTORY INSPECTION AND TESTING

A. Each pump shall be tested for performance at the factory as specified herein. Submersible pumps shall include additional testing as described under item C. below

B. Impeller, motor rating and electrical connections shall first be checked for compliance to specific requirements. Impeller shall be visually inspected to certify that it is free of defects.

C. Submersible Testing shall include but not limited to the following:

1. Conduct mechanical and electrical motor integrity tests in accordance with ANSI/HI 11.6
2. Motor and cable insulation test for moisture content or insulation defects.
3. After a submerged test run of thirty (30) minutes, Item 2 shall be retested.
4. If any deviation of above is found, the pump shall be rejected.

D. Hydrostatic Test

1. Hydrostatically test each pump casing under a hydrostatic head of 100 psig or 150 percent of rated shutoff head, whichever is greater. Tests shall be performed using the complete pump system to be furnished. Testing of prototype models will not be acceptable.

E. Capacity Testing

1. Run pump at full speed rating point for sixty (60) minutes prior to start of any testing.
2. Full Speed Test: Test pump at the specified conditions and record and tabulate readings of flow, differential pressure, BHP, efficiency, NPSHR, input kW, voltage, frequency, and power factor for each test point.
3. Furnish certified performance tests as specified for all pumps.
4. Furnish a certification that the pump horsepower demand did not exceed the rated motor horsepower beyond a 1.0 service rating at any of the test points.

3.03 PAINTING

A. After installation and approved field testing by the Engineer, the Contractor shall apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 MANUFACTURER SERVICES

A. Furnish the services of trained service technician, certified by the manufacturer to service the type of equipment specified in accordance with the requirements of the General Conditions of the Contract Documents and as specified herein.

B. The service representative must be present on site for all items listed below. Work-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

C. Assistance during functional and performance testing and startup demonstration, and product acceptance by the Owner.

1. 1 work-day.

D. Training of Owner's personnel in the operation and maintenance of equipment as required. Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom session.

1. ½ work-day.

E. For the purposes of this paragraph, a work day is defined as an eight (8) hour period at the Project site, excluding travel time.

3.05 FIELD TESTING

A. The Contractor shall obtain water for field testing of pumps from a source approved by the owner. The Contractor shall be responsible, at no additional cost to the Owner for provision of temporary piping, pumping, and other ancillary equipment necessary for delivery of water to the pump station for pump testing purposes. Test water shall be disposed of as directed by the Owner.

B. Contractor shall provide all labor, piping, equipment, portable flow meters, calibrated gauges or calibrated test gauges, and materials for conducting tests. Tests will not be acceptable if equipment calibration is not within sixty (60) days of the field testing.

C. The pumps shall be tested at start-up by the pump supplier or its authorized representative. The pump supplier shall provide a formal test procedure and forms for recording the test data.

D. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, damaging cavitation, or overheating of bearings and to demonstrate the indicated head, flow, and efficiency at the design rating point.

E. Test removal and replacement of all pumps to prove the pumps and guiderail systems are properly installed and aligned using the bridge crane installed under Section 14600.

F. After installation of pumping equipment, and after inspection, operation, testing and adjustment have been completed by manufacturer's service representative, conduct running test for each pump in presence of the Engineer to determine its ability to deliver its rated capacity under specified conditions.

G. Field testing shall not be conducted without an approved procedure and calibration certificates for all testing equipment, gauges and flow meters.

1. Startup, check and operate each pump system over its entire range of operation. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of three pumping conditions defined by the Engineer.
2. During tests, observe and record head, capacity and input kW. Calculate BHP and efficiency for each observation.
3. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to the Owner.
4. Submit a table of results with a listing of a minimum of four (4) test points throughout the pump range including rating points through shut-off head.

3.06 SERVICE CAPABILITY

A. Service Facility and Maintenance Agreement

1. The pump supplier shall have a service and repair facility, equipped with proper tools and

lifting equipment that is owned and operated by the pump supplier, within a fifty (50)-mile radius of the pump station.

2. The facility shall stock complete sets of seals, bearings, O-rings and cutter parts, etc. for each pump model to enable a maximum of seventy-two (72) hour repair after receipt of pump for maintenance or repair.

3. The facility shall have U.L. or F.M. certified mechanics on staff to service explosion proof pumps.

END OF SECTION 11200

SECTION 11221
JET MIX SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Work under this section includes furnishing, installing and testing of the jet mixing system for the equalization tank. The jet mixing system shall be comprised of the jet manifolds, manifold supports, recirculation pumps, nozzles, control description and all necessary appurtenances as specified herein. All internal piping shall be designed and supplied by the Manufacturer to the connection at the tank wall internal nozzles. The jet mixing nozzles, headers and mixing pumps shall be provided as a complete system by the jet mix system supplier.

B. The Contractor shall be responsible for the overall design and operation of the jet mix system based on the performance information specified herein.

C. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

D. Related Sections include but are not necessarily limited to:

1. Section 01600: General material and Equipment Requirements
2. Section 09900: Painting and Protective Coatings
3. Section 13150: Instrumentation and Controls Logic Description

1.02 SUBMITTALS

A. Submittals shall include, as a minimum, the following information as it relates to the equipment and operating system:

1. Shop drawings shall indicate totally the scope of the work included with the jet mix system and contain an itemized list of all deviations or exceptions to the specifications, structural configuration, drawings and details.
2. Data sheets and performance requirements for all ancillary equipment, including but not limited to mixing pump performance, construction and required support details, in-basin piping system and foundation and anchor bolt requirements.
3. Drawings showing dimensions and details of all major components and minimum recommended spacing, equipment arrangements and piping drawings.
4. Schedule of shop and field coating systems.
5. Recommended spare parts.
6. O&M Manuals.

7. List of consumables.
8. Start-up and installation requirements.
9. Installation and start-up report for each system.

1.03 ACCEPTABLE MANUFACTURERS

A. Mixing Systems, Inc.

B. Kla Systems

C. Or Equal.

1.04 WARRANTY

A. The Contractor shall furnish Manufacturer's certification and warranty that the system will perform as described in these Specifications and warrant the jet mix system, complete to be free from defects in materials or workmanship for a period of one (1) year from Owner's acceptance. The Contractor shall repair or provide replacement of any defective components under this warranty.

PART 2 - PRODUCTS

2.01 GENERAL

A. The Contractor shall be responsible for the design of the system to achieve the performance requirements specified herein.

B. The Jet Mixing system shall consist of two submerged directional jet mixer(s), each provided with in-basin liquid distribution piping, and necessary supports and hardware. Liquid recirculation shall be provided by two external centrifugal dry pit vertical immersible pumps.

C. All pumps, in-tank piping, pipe supports, and appurtenances required for a complete and operable jet mixing system shall be provided by the Manufacturer.

D. The Directional Jet Mixer shall be Model DJM as manufactured by Mixing Systems, Inc., Dayton, Ohio or equal.

E. Design Criteria

Tank Volume	10 Million Gallons
Tank Internal Diameter	185 feet
Bottom Slope	1 : 12
Tank Maximum Water Depth	50 feet (vertical wall height)
Number of Mixing Headers	2

F. The Directional Jet Mixing System shall be designed to completely mix the entire tank/basin contents once every 100 minutes and shall be designed to operate from a tank empty (pump stop

elevation) to full tank condition. With the tank full, the bulk fluid velocity shall be 0.6 fps or greater with a circular mix flow pattern in the tank.

G. Coordinate dynamic thrusts and other forces imparted on tank walls with tank design/manufacturer.

2.02 PUMPS

A. Jet Mix System Manufacturer shall determine the final recirculation pump capacity and discharge head according to the performance requirement of the System's jet nozzles, piping and requirements set forth herein. System shall effectively maintain homogenous mixture of raw sewage that has passed through grinding equipment as specified in Section 11332. The Jet mix system manufacturer shall be responsible for selecting pumps suitable for the pumping conditions and installation requirements.

B. Pumps shall be suitable for raw sewage service. Pumps shall be submersible type designed for vertical installation in a dry-well as shown on the drawings. The pumps will run continuously in air. No cooling water is provided.

C. All major parts of the pump such as the pump casing, stator casing, oil casing, etc. shall be of ASTM A-48 Class 35 minimum gray iron. All exposed bolts and nuts shall be 316 stainless steel.

D. The impeller shall be ASTM A-48 Class 35 minimum gray iron, of non-clogging design, capable of handling solids, fibrous material, heavy sludge and other matter found in normal sewage applications. The casting shall have smooth surfaces devoid of blow holes or other irregularities. The impeller shall be dynamically balanced. Static and dynamic balancing operations shall not deform or weaken it.

E. Pumps shall be nominal 100 HP suitable for operation on 460 Volt, 3 phase, 60 Hertz service.

F. Provide any and all piping, electrical, and structural adjustments necessary to suit the jet mix system components and required configuration.

G. Pumps shall be provided with a cast iron or fabricated steel support base for installation on the concrete foundations as shown on the drawings. Base shall be designed for the maximum possible loads of the pumps provided.

2.03 JET HEADER

A. Each Directional Jet Mixer shall be comprised of integrally fabricated liquid headers equipped with 48 jet nozzles. The jet nozzles shall be mounted on one side of the liquid header, equally spaced along the length of the manifold. Recirculated liquid shall enter the liquid header through a 24 inch flanged connection and the induced circulation shall enter through individual entrainment openings located on each jet nozzle.

B. The jet mixer shall be designed to provide uniform distribution of the recirculated liquid to each jet nozzle. The recirculated liquid and induced circulation shall be combined in the secondary jet nozzle and the resultant stream shall be discharged horizontally as a high energy jet in the lower regions of the basin. Each jet manifold assembly shall be shipped in the maximum lengths practical for transport and filed installation.

C. The liquid duct shall be a cylindrical member that shall be internally smooth and free from protrusions that might collect stringy material. The jet nozzles shall be aligned on a common horizontal plane. Resin to be used for the construction of the jet mixers shall be Ashland 922.

D. Individual feeds shall ensure uniform liquid distribution to each jet. Supports shall be provided as necessary. The liquid header shall be fabricated of corrosion resistant, structurally sound, filament wound, fiberglass reinforced thermosetting resin pipe conforming to ANSI/ASTM specification D-2996-81. Each jet nozzle shall consist of an inner liquid nozzle and outer liquid discharge nozzle fabricated from fiberglass reinforced plastic in accordance with NBS specifications PS-15-69. Wall thicknesses shall be as follows:

Diameter	Wall Thickness, inches
14-inch ∅ I.D.	0.31
16-inch ∅ I.D.	0.31
18-inch ∅ I.D.	0.36
20-inch ∅ I.D.	0.36
24-inch ∅ I.D.	0.41
Nozzles	0.38

E. The piping used for the construction of jet mixers and liquid pipes shall have a 100 mil corrosion liner on the pipe inside diameter.

F. The jets shall be molded and assembled to be concentric with the inner liquid and outer discharge nozzle in axial alignment. The secondary discharge nozzles shall be of constantly decreasing cross-sectional area so as to increase the velocity of the secondary mixture originating from the inner nozzle and the induced flow chamber.

G. The outlets of both the inner and outer nozzles shall be circular and shall be capable of passing a 1.5 inch spherical solid and be free from all protrusions which may collect stringy material. The secondary discharge nozzle shall have a circular orifice outlet having a diameter of from 1.7 to 1.9 times the primary liquid nozzle outlet diameter. The diameter of the secondary nozzle shall increase in the direction of the inner liquid nozzle with an included angle which shall be greater than 10° and less than 30° for at least 6-inches along the horizontal flow path of the secondary nozzle. Nozzles shall have an abraision resistant coating on the nozzle annular space. Attachment hardware for the flanges and supports shall be Type 18-8 stainless steel.

2.04 IN-TANK PIPING

A. All in-tank piping shall be provided as a part of the system. The piping shall be of adequate length and diameter to transport the motive liquid from each flange on the inside of the tank wall to the jet headers. In-tank piping shall be machine filament wound, fiberglass reinforced thermosetting resin pipe fabricated using Vinyl Ester resins in strict accordance with ASTM Specification D-2996. Design working pressure for the piping system shall be 100 psi minimum.

B. Flanged connections shall be provided for connecting the jet system headers to the out-of-basin piping (by others). Gaskets and Type 18-8 stainless steel connection hardware shall be supplied for all connections except supplier/contractor interface. Piping shall be assembled in the field by the installation contractor. Installation hardware and FRP field wraps are to be supplied by the installation contractor.

C. The limits of in-tank liquid piping to be provided shall be from the jet header to the tank mounted nozzle connection and shall include a flexible coupling at the tank nozzle connection.

2.05 SUPPORTS

A. All necessary supports and hardware for installation of the System in the tank shall be provided as part of the System by the manufacturer. All hardware supplied shall be Type 316L stainless steel.

B. All submerged supports shall be constructed of Type 316 stainless steel and spaced on a maximum of ten (10) feet centers.

C. Pipe supports shall include a contoured saddle welded to a supporting base. The support base shall be anchored to the tank floor with epoxy set anchor bolts. A bolted clamp shall hold the piping to the saddle. The saddle and clamp shall be provided with Neoprene rubber pads to prevent abrasion. Stainless steel anchor bolts of minimum 1/2 inch shall be provided by the System manufacturer.

2.06 ADDITIONAL EQUIPMENT

A. Flexible coupling between tank nozzles and internal piping and other appurtenances as detailed and specified.

2.07 MISCELLANEOUS

A. Nuts, bolts, and washers shall be ASTM A276 18-8 type 304 stainless steel. Other non-welded parts shall be ASTM A473 Type 316L stainless steel. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

PART 3 - EXECUTION

3.01 FABRICATION:

A. All fiberglass reinforced plastic molding and lamination shall be done in factory. No field molding and lamination shall be permitted. Liquid manifold sections shall be shipped in the longest lengths possible. The manifold sections shall be field connected utilizing flange by flange connections.

3.02 INSTALLATION

A. The system shall be installed and adjusted/leveled in accordance with the manufacturer's written instructions.

B. Contractor shall provide all recommended oils, greases and lubricants required for initial start-up and operation.

3.03 PERFORMANCE TESTS

A. The test procedures specified in this section are a valid basis for determining the ability of the jet mix system to meet the performance requirements specified.

B. After complete installation of the jet mix system, the Contractor, under the direction of the manufacturer's representative, shall conduct in the presence of the Owner, or Owner's

representative, such tests as are necessary to ensure that jet mix system operation conforms to the Specifications. Field tests shall include all testing and measurement equipment. Field tests shall validate compliance with specified performance requirements.

C. Verify a bulk fluid velocity of 0.6 fps or greater for a circular mix flow pattern in the tank when filled (full) with water or other Contractor supplied test medium. The velocity measurements shall represent a spatial average of no less than 4 elevations and 4 radial locations (16 points) within the lower 8 feet of the tank depth. Measurement locations shall be equally spaced vertically and radially. Radial locations shall be at a 45° angle between mix headers throughout the tank utilizing a Doppler or propeller type velocity meter. Submit details for monitoring and recording data and mounting instrumentation. Alternate testing requirements can be proposed by the jet mix manufacturer for approval by the Engineer.

3.04 MANUFACTURERS SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for installation assistance, start-up, testing and training. The minimum man-days listed for the services excluding travel time shall be:

1. Six, 8-hour days over three trips for installation assistance, inspection, testing and certification of the installation

B. Training of Owner's personnel shall be at such times as requested by the Owner.

3.05 CLEANING

A. Prior to acceptance of the Work of this Section, thoroughly flush and clean all installed equipment, materials and related areas.

3.06 PAINTING

A. The Contractor shall provide field paint touch-up of all installed in-tank equipment in accordance with the manufacturer's standard finish coating system. All equipment installed in the EQ pump station and external to the tanks shall be coated in accordance with Section 09900.

END OF SECTION 11221

SECTION 11284
SLUICE GATES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of sluice gates. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings. The sluice gate manufacturer shall be responsible for the complete gate system including the design and supply of the electric gate operators.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Related work specified elsewhere:

1. Section 01600, General Material and Equipment Requirements

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's data, materials of constructions and dimensions drawings showing all details, dimensions, mounting requirements, operational clearances, and any other information required to completely define the gates to be provided.
2. Relevant experience references.
3. Complete wiring and control diagrams.
4. Operation and maintenance manuals.
5. Manufacturer's certification.
6. Installation and start-up report for each unit.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electrical Code.
2. NEMA, National Electrical Manufacturers Association

3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ASTM, American Society for Testing Materials.
6. AISI, American Iron and Steel Institute.
7. AGMA, American Gear Manufacturer's Association.
8. ABMA, American Bearing Manufacturer's Association.
9. AWWA, American Water Works Association

B. Experience: Equipment furnished under this Section shall be of a design and manufacturer that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation for a minimum period of 5 years. Provide a list of such installations with installation description, contact names, addresses and telephone numbers.

C. Should the gates not perform as required, the Contractor shall repair or replace any units as necessary to meet the Specifications. Costs for unit repair and retesting shall be the Contractor's responsibility.

1.04 QUALITY STANDARDS

A. The sluice gates shall be furnished by a single manufacturer who shall assume full responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings. The Contractor shall assign unit responsibility as specified in Section 01600, General Material and Equipment Requirements, to the sluice gate equipment manufacturer for equipment specified in this Section. A certificate of unit responsibility shall be provided.

B. Manufacturers shall provide written calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these Specifications include:

1. Rodney Hunt Company
2. Whipps
3. Waterman Industries
4. Or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only.

B. Specific information relative to the various sluice gates including gate type, identification numbers, design head conditions, gate sizes, mounting requirements, methods of operation, operator type, and other information is tabulated within the Gate Schedule as shown on the Process drawings.

C. All gates shall be complete including all gates, guides, frames, bench stands, floor stands, baseplates, brackets, anchor bolts, stems, stem guides, operators, and all other necessary appurtenances.

2.02 SLUICE GATES

A. General

1. Gates and appurtenances shall be supplied in accordance with the latest edition of ANSI/AWWA C560 Standard for Cast Iron Slide Gates as modified herein.
2. Leakage shall not exceed 0.01 gpm/ft of wetted seal perimeter in seating head and 0.02 gpm/ft of wetted seal perimeter in unseating head conditions
3. Sluice gates shall meet the design requirements shown in the Gate Schedule included on the Process Drawings.
4. All surfaces of gate in contact with concrete shall be shop coated with an alkali resistant coating.
5. All exposed surfaces shall be of corrosion resistant material or painted with a protective coating suitable for wastewater environment.

B. Materials of construction for sluice gate components are specified as follows:

1. Frame, Slide, Wall Thimble, Pedestal, Gear Housing, Wall Brackets, and Stem Guide Brackets: Ni-Resist cast iron, ASTM A436, Type 2 or 2b
2. Wedge and Wedge Blocks: Monel, Federal Spec. QQ-N-288, Composition A
3. Lift Nut Bronze: ASTM B584, Alloy C86500
4. Stem Block Stainless steel: ASTM A743, CF8M
5. Seating Faces: Monel, ASTM B164, UNS N04400 or N04405
6. Stems and Stem Couplings: Monel, ASTM B164, UNS N04400 or N04405, Cold Worked
7. Fasteners Stainless Steel: ASTM F593/F594, Alloy Group 2 (316)
8. Flush-Bottom Seal: Neoprene, ASTM D2000
9. Flush-Bottom Retainer Stainless steel: ASTM A276, Type 316

C. Guides and Frames

1. The gate frame and guides shall be one-piece integral cast iron casting.
   a. Frame design shall allow for mounting directly to a wall with stainless steel anchor bolts and grout or mounting to a wall, wall thimble, or a pipe flange. Frames with a spigot-back arrangement are not allowed. Mounting style shall be as shown on the Contract Drawings.
   b. Round opening gates shall have a circular flange cast as part of the frame for mounting to a wall or pipe flange.
   c. All wall thimble-mounted gates shall have a square or rectangular flanged-back frame. The frame shall be fully machined and drilled to match the wall thimble.
   d. The frame shall extend to support a minimum of one-half the entire height of the slide when the slide is in the fully opened position on upward opening gates or downward opening weir gates.
   e. On self-contained gates, a yoke shall be provided across the top of the frame. The yoke shall be cast iron or structural steel to provide a rigid assembly. The yoke shall be designed to allow removal of the slide. The yokes shall be bolted to machined pads on the gate frame.

D. Seating Faces

1. Corrosion-resistant seating faces shall be mounted around the perimeter of the slide and frame. They shall be impacted into dovetail slots and held in position without use of screws or other fasteners.

E. Wedges

1. Each gate shall be provided with a sufficient number of wedges to provide water-tightness.
   a. Side wedging devices shall be designed to make full metal-to-metal contact with the overhung portion of the frame-mounted wedge block.
   b. Wedges shall be fully adjustable and keyed to prevent any lateral rotation.
   c. Side wedges shall be machined with angled faces and secured with a stud bolt to prevent any slippage during operation of the gate.
   d. Gate shall be designed with adjustable top and bottom wedges attached to the frame and slide. Wedges shall be mounted in such fashion that prevents lateral rotation.
   e. For flush bottom seals, the differential pressure on the rubber seal shall be variable by adjustment of wedges on the gate.

F. Slide

1. The gate slide shall be cast iron and shall be of one-piece construction. The slide shall be square or rectangular in shape with integrally cast vertical and horizontal reinforcing ribs to ensure rigidity.
2. The slide shall be designed to operate under maximum specified unbalanced head with the minimum safety factory of five. Guide tongues along each side of the slide shall be machined all over. A nut pocket shall be cast on the vertical centerline of the gate and shall be provided with a threaded block for attaching the stem to the slide.

Pads for side wedges and top and bottom wedges, when required, shall be integrally cast on the slide and machined to receive the adjustable wedges.

G. Stem

1. A threaded operating stem shall be utilized to connect the operating mechanism to the slide. On rising stem gates, the threaded portion shall engage the operating nut in the manual operator or motor actuator. On non-rising stem gates the threaded portion shall engage the nut on the slide.
   a. The threaded portion of the stem shall have a minimum outside diameter of 1-1/2 inches. Stem extension pipes are not acceptable.
   b. The stem shall be constructed of solid stainless steel bar for the entire length, the metal having a tensile strength of not less than 75,000 psi.
   c. The stem shall be threaded to allow full travel of the slide unless the travel distance is otherwise shown on the Contract Drawings.
   d. Maximum L/R ratio for the unsupported part of the stem shall not exceed 200.
   e. The threaded portion of the stem shall have machine rolled threads of the full Acme type with a 16 microinch finish or better. Stub threads are not acceptable.
   f. Stems of more than one section shall be joined by stainless steel or bronze couplings. The coupling shall be bolted to the stems.
   g. Stems, on manually operated gates, shall be provided with adjustable stop collars to prevent over closing of the slide.

H. Stem Guides

1. Stem guide shall be provided when necessary to ensure that the maximum L/R ratio for the unsupported part of the stem is 200 or less.
   a. Stem guide brackets shall be fabricated of stainless steel and shall be outfitted with UHMW or bronze bushings.
   b. Stem Guides shall be adjustable as required to provide proper alignment.

I. Wall Thimbles

1. Wall thimbles shall be provided when shown or specified on the Contract Drawings.
   a. The wall thimble depth shall be equal to the thickness of the concrete wall in which the thimble is to be mounted.
   b. Wall thimble shall be a heavy, one-piece iron casting of an E, F or mechanical joint type configuration.
   c. The wall thimble shall be square and plumb and the front face is sufficiently flat to provide a proper mounting surface for the gate frame.
   d. A water stop shall be welded around the periphery of the thimble. Wall thimbles shall be designed to allow thorough and uniform concrete placement during installation.
   e. Studs and nuts shall be stainless steel.
   f. A suitable gasket or mastic shall be provided to seal between the gate frame and the wall thimble.

J. Flush-Bottom Seal

1. Flush-bottom gates shall be provided with a frame-mounted flush-bottom solid bulb resilient rubber seal.
2. The full length of the bottom edge of the slide shall make uniform contact with the seal.

K. Yokes

1. Yokes of self-contained gates shall be cast iron or structural steel. They shall be designed to withstand the thrust of the manual lift when a 40 pound pull is placed on the handwheel or crank with a safety factor of 5 based on the ultimate strength of the material used. The yokes shall be bolted to machined pads on the gate frame.

2.03 STEM COVERS

A. Each rising stem type gate shall be provided with a transparent plastic vented pipe stem cover and cap. Stem covers shall be guaranteed not to discolor, crack, or become opaque for at least 5 years after installation Provide stem covers with OPEN/CLOSED designators with 1-inch graduations on clear mylar pressure sensitive, adhesive tape, suitable for outdoor application.

2.04 GATE OPERATORS

A. General

1. Operators shall meet ANSI/AWWA C540, Standard for Power Actuating Devices for Valves and Slide Gates, except as otherwise specified, and shall be designated to meet the operating requirements specified in the gate schedule.
2. Unless otherwise indicated, operators shall be located 36 inches above the operating floor.

B. Motor Operator

1. Each motor operated gate shall include an electric gate actuating unit mounted on and assembled to the gate. Actuators shall be electric motor driven gear reducer with integral controls and thrust bearing. The actuator shall be sized to open and close the gate at the operating pressure as determined by the gate manufacturer.
2. Each unit shall consist of a motor, reduction gearing, handwheel gearing, operating limit switches and torque limiting switches within one NEMA rated enclosure. All actuators located outdoors shall have thermostatic strip heater to prevent condensation.
3. Each motor shall be high torque, totally enclosed in a NEMA rated housing. The motor starting torque shall be equal to 2-½ times the running torque. The motor shall have AIEE standard Class F insulation. The grease tight operation shall be assured by the use of dual motor shaft seals.
4. The gearing shall be combined helical/spur and worm gear type, accurately machined. Helical gears shall be alloy steel, hardened and ground. Gearing shall be grease lubricated, with high speed parts on antifriction bearings. An inspection plate on the housing shall be provided to allow inspection of the handwheel declutching mechanism, the motor gears, and for re-lubrication.

5. Each unit shall include a handwheel for manual operation of the valve drive sleeve through direct gearing. The handwheel shall not rotate during electrical operation. The motor shall not rotate during hand operation. In no case will the handwheel ever be connected with the motor. When the unit is being operated manually, it shall be automatically returned to the electric operation when the handwheel is released. Handwheel shall be lockable to prevent unauthorized access.

6. The transfer from electric to manual operation shall be accomplished by a declutching lever arm which will disengage the motor mechanically but not electrically. The unit shall be capable of being clutched or declutched when operated electrically with no damage to the clutch or gear mechanism.

7. The actuator shall operate on power supply specified on the electrical drawings and the Gate Schedule on Drawing D0-602. All controls shall operate on 115 volt AC power and a control power transformer shall be provided within the unit as required.

8. The controls shall provide a reversing actuator, mechanical and electrical interlock, and thermal overload relays. The contactor shall break all lines to the motor.

9. Position limit switches shall be provided for both open and close positions of travel and shall be connected directly to the gate through continuous gearing, and follow its position at all times. Mechanisms employing intermittent tooth gearing and rotary drive switches are not acceptable.

10. A double acting, adjustable torque limit switch shall be provided, capable of detecting excessive torque caused during seating, unseating, or obstructions. Torque control accuracy shall be within ± five percent.

11. The controls shall provide for local and remote operation. The local pushbutton control shall be provided with open, close and stop pushbuttons, open and close indicator lights, local/remote selector switch. In "REMOTE" actuator shall accept a form "C" dry contact for OPEN/CLOSE operation. In "REMOTE" the Selector Switch shall close a separate set of dry contacts to provide remote status that the Local-Off-Remote selector switch is in the REMOTE position.

12. Actuators shall be NEMA 6/IP68 rated for submerged service to 45 ft. for 96 hours.

13. When specified on the schedule, actuators shall include a lockable vandal resistant cover that will completely enclose the actuator as necessary to prevent unauthorized access to any of the actuator comonents.

14. Motorized actuators shall be Rotork, IQ, Limitorque MX Series or equal.

2.05 ACCESSORIES

A. All necessary attaching bolts, anchor bolts, mounting and assembly hardware shall be of Type 316 stainless steel and shall be furnished by the slide gate manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Insofar as practical, the sluice gate assemblies shall be completely factory assembled, shipped as a unit, disassembled on site and installed in strict conformance with the manufacturer's recommendations. The parts and assemblies that are, of necessity shipped unassembled shall be

packaged and tagged in a manner that will protect the equipment from damage and facilitate the final identification and assembly in the field.

B. All anchor bolts and necessary bolt setting plates shall be provided by the manufacturer. Two nuts shall be provided for each anchor bolt, and anchor bolts shall be cast-in-place during

C. All stainless steel bolts shall be coated with an anti-galling compound before the nuts are attached and tightened.

D. All gates shall be thoroughly cleaned and shall operate without vibration or binding.

3.02 FIELD TESTS

A. Field leakage tests shall be performed as specified in AWWA C560.

B. Field leakage tests shall be conducted with no head on the side being tested.

3.03 MANUFACTURERS' SERVICES

A. Manufacturers' services shall be provided in accordance with Section 01600, General Material and Equipment Requirements. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Engineer for the minimum days listed for the services herein, travel time excluded:

1. A minimum of two trips of 1 day duration each trip for installation assistance, inspection, functional and performance testing, and certification of the installation.

END OF SECTION 11284

SECTION 11332
OPEN CHANNEL ELECTRIC GRINDERS

PART 1 - GENERAL

1.01 SCOPE

A. This section of the specification describes the submersible sewage grinders and controllers. The equipment shall be installed as shown on the plans, as recommended by the supplier, and in compliance with all OSHA, local, state and federal codes and regulations.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Division 13 – Instrumentation and Controls
2. Section 13150 Instrumentation and Controls – General Description
3. Section 13200 Control Panels
4. Section 13250 Control Panel Components
5. Section 13270 Surge and Lightning Protection
6. Section 13400 Programmable Controllers
7. Division 16 - Electrical

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's data: Dimensions; materials; size and location of all loads imposed on supporting structures; size and location of any concrete blockouts; size and location of anchor bolts and any required clearances.
2. Performance data for grinder and motor including hydraulic performance curves showing flow rate and head loss, motor characteristics, etc.
3. Details of all grinder control panels, protective control devices, leakage sensors, bearing temperature sensors, motor temperature sensors, etc. to define all components to be included.
4. Factory testing procedures and factory test results.
5. Field testing procedures, equipment to be used and calibration certificates. Submit a minimum of 2 weeks prior to field testing.
6. Complete wiring and control diagrams, wiring sizes and wiring specifications.

7. List of recommended spare parts, including those specified herein.
8. Location of nearest authorized service center.
9. Recommendations for short and long-term storage.
10. Operation and Maintenance Manuals. The supplier shall provide three (3) printed copies Operation & Maintenance manuals and three (3) electronic copies on compact disk. The manuals shall include equipment descriptions, operating instructions, drawings, troubleshooting techniques, a recommended schedule, and the recommended lubricants.
11. Manufacturer's Certification as specified herein.
12. The grinder manufacturer shall submit their requirements for grinder exercising during extended periods when process operation is not required as described herein.
13. Installation and start-up report for each unit grinder unit/system.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ASTM, American Society for Testing Materials.
6. AISI, American Iron and Steel Institute.
7. SAE, Society of Automotive Engineers
8. ABMA, American Bearing Manufacturer's Association.
9. NFPA, National Fire protection Association.

B. Experience: Equipment furnished under this Section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have a demonstrated record of successful operation of the furnished equipment for a minimum period of 5 years, and a minimum of five similar applications. Provide a list of such installations complete with installation description, contact names, addresses, and telephone numbers. Contact information shall be up to date and current as of the date of bid opening. This reference list shall be submitted with the bid documents.

C. Single Source Responsibility: The grinder supplier shall supply the following components and systems, and be responsible for the design, integration and proper system operation of these components:

1. Open channel grinders.
2. Submersible electric motor.
3. Grinder control panel.

4. Power and signal cables from motors to the first junction box.
5. Power and signal cable handling, support and storage systems.
6. Grinder installation and retrieval system.
7. Grinder control and monitoring system.

D. Manufacturers offering products that comply with these Specifications include:

1. Grinder and controller shall be a Model CDD5020-XDM2.5 as manufactured by JWC Environmental of Costa Mesa, CA
2. Or equal.

1.04 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 GENERAL

A. One submersible motor-driven, guide rail mounted, open channel grinder shall be installed at each inlet to the Diversion Pump Station wet well. A total of four units shall be furnished. The unit shall shred and process rags, paper, chunks of wood, bottles, plastics, stringy material, and other solids common to municipal wastewater.

B. Each unit shall have a design capacity as follows:

1. Grinder shall be capable of processing 20 MGD with a maximum headloss of 28 inches of water column.
2. Grinder shall provide a minimum peak shaft torque of 3,700 lb-in/hp.
3. Grinder shall provide a minimum peak force at cutter tip of 990 lbf/hp.
4. Grinders shall cut debris into material that is a nominal 1/2" x 1/8" in size.

C. The unit shall be installed on slide rails such that the entire unit can be removed from the wet well without requiring any personnel to enter the wet well area. Slide rails and base support shall be provided by grinder manufacturer.

2.02 GRINDER

A. Grinders shall reduce or shred influent solids for protection of downstream equipment. Grinder shall be two shafted design consisting of individual cutters and spacers, with cutters on drive and driven shafts of equal diameter. The grinder shall have two rotating screen drums that shall collect solids too large to pass through the screen drums and direct them to the cutters for solids reduction. Grinder shall have individual motors and speed reducers for cutter drive shaft and each screen drum.

1. Cutters and Spacers
   a. Cutting stack shall be a nominal height of fifty (50) inches.
   b. Cutter shall be an individual disk constructed of AISI 8620 alloy steel surface ground to thickness of .875-inches +.000/-.001.
   c. Cutters shall be heat treated to produce a hardness of 60-65 Rockwell C.
   d. Cutters shall have 7 cam shaped teeth. Tooth height shall not be greater than 11/16-inch above root diameter of the cutter. OD shall be 7.50-inches.
   e. Spacers shall be an individual disk constructed of AISI 8620 alloy steel surface ground to a thickness of .884-inches +.001/-.000.
   f. Spacers shall have a hardness of 34-38 Rockwell C.
   g. Spacers shall have a smooth outside diameter with no tooth profiles.
2. Shafts
   a. Shafts shall be constructed from AISI 4140 alloy steel with a minimum tensile strength of 170,000 PSI.
   b. Shafts shall be a nominal 2-1/2inches across flats of hex.
   c. Shafts shall be hardened to 38-42 Rockwell C.
3. Intermediate Shaft Collars with Vertical Support Structure
   a. Intermediate shaft collars shall be constructed of ASTM A743 stainless steel, AISI 17-4 stainless steel and SAE 660 bearing bronze.
   b. Shaft collars shall be lubricated with high temperature marine grade grease at the factory.
   c. Grease fittings on the shaft collars shall be provided for periodic maintenance.
   d. Intermediate shaft collars shall provide radial support to the shafts during severe grinding demands.
   e. Vertical support structure shall be constructed of 304 stainless steel.
   f. Vertical support structure shall have brackets to locate and secure intermediate shaft collars within the cutter stack.
   g. Vertical support structure shall have a shape that coincides with the radial profile of the cutters to allow for a close interface.
   h. Vertical support structure shall have adjustable brackets for mounting to the top and bottom end housings.
4. Seal Cartridges
   a. Seal cartridges shall be rated to a maximum of 90 PSI.
   b. Seal cartridges shall not require flushing.
   c. Dynamic and rotating seal faces shall be constructed of tungsten carbide with 6% nickel binder.
   d. O-rings shall be constructed of Buna-N (Nitrile).
   e. Radial and axial loads shall be borne by sealed, oversized, deep-groove ball bearings.
5. Housings and Covers
   a. End housings and top cover shall be constructed of ASTM A536 ductile iron.
   b. End housings shall have integral bushing deflector to guide solids from seal cartridges.
   c. Bottom cover shall be constructed of ASTM A-36 rolled steel.

6. Side Rails
   a. Side rails shall be constructed of ASTM A536 ductile iron.
   b. Side rails shall have a UHMW sealing strip for creating an adjustable interface between the side rail and the rotating drum.
   c. Side rails shall have integral guide slot for installing into framework.
7. Coil Screen Drums
   a. Coil screen drums shall be constructed of helical wound ½-inch diameter AISI 304 stainless steel with ½-inch spacing between coils.
   b. Coil screen drums shall have vertical supports, center ring supports, end flanges, and stub shafts to properly support the coils.
   c. Coil screen drums shall have no shaft in center of drum.
   d. Coil screen drums shall be electro-polished.
8. Speed Reducer-Cutters
   a. Reducer shall be manufactured by Sumitomo Machinery Corporation of America.
   b. Reducer shall be internal planetary mechanism with trochoidal curved tooth profile.
   c. Reducer shall be a vertically mounted with 29:1 single reduction.
   d. Reducer shall be grease lubricated.
9. Speed Reducer-Screen Drums
   a. Reducer shall be manufactured by Sumitomo Machinery Corporation of America.
   b. Reducer shall be internal planetary mechanism with trochoidal curved tooth profile.
   c. Reducer shall be a vertically mounted 377:1 double reduction.
   d. Reducer shall be grease lubricated.
10. Motor-Cutters
   a. Motor shall be 10 HP, XPNV, 1765 rpm, 230/460 volt, 3 phase, 60 Hz
   b. Motor shall be U.L. rated NEMA 6P, Class I, Div. I Groups C&D,
   c. Motor shall have additional rating of 7 consecutive days of submergence at a maximum depth of 30 feet.
   d. Motor shall not utilize fan cooling at any time during operation when submerged or completely exposed in air.
   e. Motor shall utilize ceramic shaft seal requiring no oil lubrication.
   f. Motor shall have a minimum service factor of 1.15, 91% minimum efficiency factor at full load, minimum 80% power factor at full load.
11. Motor-Screen Drums
   a. Motor shall be 1 HP, XPNV, 1740 rpm, 230/460 volt, 3 phase, 60 Hz.
   b. Motor shall be U.L. rated NEMA 6P, Class I, Div. I Groups C&D.
   c. Motor shall have additional rating of 7 consecutive days of submergence at a maximum depth of 30 feet.
   d. Motor shall not utilize fan cooling at any time during operation.
   e. Motor shall utilize ceramic shaft seal requiring no oil lubrication.
   f. Motor shall have a minimum service factor of 1.15, 85.5% minimum efficiency factor at full load, minimum 70% power factor at full load.

2.03 FRAME AND SUPPORTS

A. General

1. Frame shall provide a method for properly securing the grinder in the wet well. The frame shall allow installation or removal without any disassembly of the frame or grinder.

B. Components

1. Frame and slide rail system shall be constructed of AISI 316 stainless steel.
2. Frame shall provide proper support and interface to prevent unwanted bypass.
3. Frame shall utilize guides that insert into the grinders side rail slots to properly position and locate the grinder.
4. Frame shall provide proper support and interface to prevent unwanted bypass and fit to the inner wall of the pump station as shown on the drawings. A guide rail shall be provided.
5. The unit will be fitted with a lifting bail system constructed of 304 Stainless Steel for removal of the grinder from the frame utilizing the guide rail system for ease of removal of the grinder from the wet well.

2.04 CONTROLLER

A. General

1. Controller shall provide control of the each grinding system. The controller shall provide control of the grinder motor and two screen drum motors. The controller shall have an Operator Interface Terminal, indicator lights, switches and other control devices.
2. Grinder operation shall be coordinated with the pump station controls as specified in Section 13150.

B. Components

1. Enclosures
   a. Enclosure shall be 316 stainless steel NEMA 4X.
   b. Enclosure shall house the OIT, control devices, motor starters, and PLC.
2. Operator Interface Terminal (OIT)
   a. OIT shall display equipment status, alarm and fail conditions.
   b. OIT shall provide operational information on reversals, jams, overloads and over temps.
3. Grinder ON-OFF-REMOTE three-position, NEMA 4X selector switch
   a. In the OFF position, the grinder shall not run.
   b. In the ON position, the grinder shall run continuously.
   c. In the REMOTE position, the grinder shall start and stop as controlled by an external input.
   d. In "REMOTE" the Selector Switch shall close a separate set of dry contacts to provide remote status that the Local-Off-Remote selector switch is in the REMOTE position
4. Screen Drum ON-OFF-AUTO three-position type, NEMA 4X selector switch

a. In the OFF position, the screen drum shall not run.

b. In the ON position, the screen drum shall run continuously.

c. In the AUTO position, the screen drum shall start and stop as controlled by grinder operation.

d. In "AUTO" the Selector Switch shall close a separate set of dry contacts to provide remote status that the ON-Off-AUTO selector switch is in the AUTO position.

5. Reset Pushbutton
   a. Pushbutton shall be momentary type 22 mm, rated NEMA 4X.
   b. Pushbutton shall be the only method of resetting the controller after failure.

6. Pilot Lights
   a. Lights shall be LED rated NEMA 4X.
   b. Lights shall indicate GRINDER RUN, SCREEN DRUM RUN, and FAIL.

7. Programmable Logic Controller (PLC)
   a. PLC shall be provided to control all grinder operations and provide feedback to the pump station local control panel.
   b. Programmable Logic Controller shall be manufactured by Allen-Bradley.

8. Motor Starters
   a. Starters shall be a full-voltage reversing type with 120 volt operating coils.
   b. Overload relays shall be adjustable and sized to full load amperes (FLA) of the motor.

9. Main Circuit Breaker Disconnect and Motor Branch Circuit Protection Circuit Breakers
   a. Circuit breakers shall be molded case type 3-pole, 480 volt.
   b. Circuit breakers shall be sized to applicable NEC and UL standards.

10. Control Component Requirements
    a. Control transformer shall be provided as required for grinder operations.
    b. Control transformer primary and secondary shall be fused for over current protection.
    c. Current transducers shall have adjustable set point from 1-135A with a 200ms or less response time.
    d. Control relays shall be rated for 10A (resistive load), DPDT, 120V with indicator light.
    e. Provide dry contacts for Grinder Running, Screen Drum Running, Common Trouble, Grinder ON-OFF-REMOTE selector switch in Remote, and Screen Drum ON-OFF-AUTO selector switch in AUTO.

C. Performance

1. When a grinder jam condition occurs, the controller shall stop the grinder and reverse the grinder rotation to clear the obstruction. If the jam is cleared, the controller shall return the grinder to normal operation. If three (3) reverses occur within a 30 second interval, the controller shall stop the grinder motor and activate the grinder FAIL indicator and relay.

2. When a Screen Drum jam condition occurs, the controller shall stop the screen drum and reverse the screen drum rotation to clear the obstruction. If the jam is cleared, the controller shall return the screen drum to normal operation. If two (2) reverses occur within a 30 second interval, the controller shall stop the screen drum motor and activate the FAIL indicator and relay. The grinder and other screen drum shall continue to operate.

3. When a power failure occurs while the grinder and screen drum is operating, the grinder and screen drums will resume operation once power is restored.

4. When a power failure occurs while the grinder or screen drum(s) is in a fail condition, once power is restored the fail indicator shall reactivate and remain until reset.

5. Reset of the grinder and drums shall be accomplished from the controller only.

2.05 SPECIAL OPERATING CONDITIONS

A. The open channel grinder systems may not be required to operate to meet the process requirements for extended periods of up to several months when there is no flow into the pump station. The manufacturer shall consider these conditions and specify any special maintenance requirements necessary to guarantee the long term operability of the equipment. It is anticipated that during the extended periods of inactivity, the grinders will be cycled or "bumped" for short periods for maintenance purposes. This process will occur "dry" with no water in the wet well. The equipment manufacturer shall specify the frequency and duration required for each grinder maintenance cycle. These settings will be included in the main control system. The manufacturer shall also include any other special maintenance requirements for their equipment to meet these conditions. This information will be submitted with the shop drawings as specified above.

2.06 IDENTIFICATION

A. Each unit of equipment shall be identified with a corrosion resistant nameplate, securely affixed in a conspicuous place. Nameplate information shall include equipment model number, serial number, manufacturer's name and location.

2.07 SPARE PARTS

A. The manufacturer shall have a local repair facility located within 50 miles of the project location. The facility shall have been in operation for greater than 30 years providing parts, service and repairs.

B. The manufacturer shall maintain a complete inventory of all spare parts at their local repair facility.

C. The manufacturer shall provide the service of rebuilding a unit for only the cost of the parts supplied.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Grinders and controllers shall be installed in accordance with manufacturer's installation instructions, the approved shop drawings and in accordance with all OSHA, local, state, and federal codes and regulations.

B. Installation shall include furnishing oil, grease, and lubricants required for initial operation. The grades of oil, grease, and lubricants shall be as recommended by the manufacturer.

3.02 PAINTING

A. After installation and approved field testing by the Engineer, the Contractor shall apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.03 MANUFACTURER SERVICES

A. Furnish the services of trained service technician, certified by the manufacturer to service the type of equipment specified in accordance with the requirements of the General Conditions of the Contract Documents, Section 01600 and as specified herein.

B. The service representative must have a minimum of five years of experience, supervising the installation and inspection of the type and size of equipment specified.

C. The service representative must be present on site for all items listed below. Work-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

D. Provide assistance to the Contractor during equipment installation including, but not limited to observation, guidance, instruction of contractor's assembly, erection, installation or application procedures, inspection and checking of installation and furnishing of written approval of installation.

1. 2 work-days.

E. Assistance during functional and performance testing and startup demonstration, and product acceptance by the Owner.

1. 2 work-days.

F. Training of Owner's personnel in the operation and maintenance of equipment as required. Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom session.

1. 1 work-day.

G. For the purposes of this paragraph, a work day is defined as an eight hour period at the Project site, excluding travel time. The Engineer may request that a work day be furnished in a maximum of two trips. All unused work days shall be credited to the Owner at the manufacturer's published field service rate.

H. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.04 TESTING

A. Test removal and replacement of all grinders to prove the grinders and guiderail systems are properly installed and aligned using the bridge crane installed under Section 14600.

B. Test each grinder to demonstrate correct alignment and smooth operation. Operate each unit and demonstrate compliance with these specifications. Operation shall be free of excessive noise, vibration, leaks, high temperatures, or other malfunctions.

C. Test period shall demonstrate simulated jam conditions for both grinder and screen drums.

END OF SECTION 11332

SECTION 11600
PACKAGE GRINDER PUMP STATIONS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of a package pump station, including wet and dry pit installations and appurtenances. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications and the manufacturer's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Section 03000 - Concrete
2. Section 09900 - Painting.
3. Section 15060 - Piping and Appurtenances
4. Section 15100 - Valves and Piping Appurtenances
5. Division 13 - Instrumentation and Control
6. Division 16 - Electrical

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Relevant experience references per requirements of paragraph 1.03 B.
2. Field testing procedures, equipment to be used and calibration certificates. Submit a minimum of 2 weeks prior to field testing.
3. Shop Drawings, Show fabrication and installation details for each packaged pumping station. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   a. Wiring Diagrams: Power, signal, and control wiring.

   Data, regarding pump and motor characteristics and performance including:
4. Complete wiring and control diagrams, wiring sizes and wiring specifications.
5. List of recommended spare parts, including those specified herein.

6. Location of nearest authorized pump service center.
7. Recommendations for short and long-term storage.
8. The pump manufacturer shall submit their requirements for pump exercising during extended periods when process operation is not required as described herein.
9. Maintenance Data: For packaged pumping stations to include in maintenance manuals.
10. Warranties: Special warranties specified in this Section.
11. Field test reports.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electric Code.
2. NEMA, Standards of National Electrical Manufacturers Association.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. ASTM, American Society for Testing Materials.
6. AISI, American Iron and Steel Institute.
7. HI, Hydraulic Institute Standards.
8. ABMA, American Bearing Manufacturer's Association.
9. NFPA, National Fire protection Association.

B. Experience: Equipment furnished under this Section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have a demonstrated record of successful operation of furnished equipment for a minimum period of 5 years, and a minimum of five similar applications. Provide a list of such installations complete with installation description, contact names, addresses, and telephone numbers. Contact information shall be up to date and current as of the date of bid opening.

C. Single Source Responsibility: The pump supplier shall supply the following components and systems, and be responsible for the integration and proper system operation of these components:

1. Submersible (wet pit) pumps.
2. Wet well structure.
3. Power and signal cables from motors to the first junction box.
4. Power and signal cable handling, support and storage systems.
5. Pump control and monitoring system.
6. Pump base, support brackets, and other ancillary items

1.04 QUALITY STANDARDS

A. All submersible pumps specified in this Section shall be furnished by a single supplier who shall assume sole responsibility for providing a complete, operating system designed for long life with minimum required maintenance, meeting the requirements specified herein and as shown on the Drawings.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

C. Manufacturers offering products that comply with these Specifications include:

1. Environmental One Corporation (E/ One).
2. Or Equal

1.05 WARRANTY

A. Provide a 5-year warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 STORAGE AND PROTECTION

A. Pumps and accessories shall be stored and protected in accordance with the requirements of the General Conditions of the Contract Documents and manufacturer's recommendations.

PART 2 - PRODUCTS

2.01 WET-WELL, PACKAGED PUMPING STATIONS WITH SUBMERSIBLE GRINDER SEWAGE PUMPS

A. Description: Factory fabricated, assembled, and tested with wet well for sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.

B. Orientation: Shell underground with dry equipment chamber underground with top 6 inches above grade

a. Shell: Factory fabricated from polyethylene or fiberglass.
b. Sewage Pumps: Two submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.

C. Pumps shall be suitable for pumping raw sewage containing solids consisting of grit and organic materials and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 40° to 104° F. The pumps supplied under this specification shall be suitable for continuous operation under submerged or partially submerged conditions.

D. Pumps installed in wet pit locations shall be automatically and firmly connected to the discharge connection elbow. Pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fasteners to be removed for this purpose and without requiring physical entry into the confined area.

E. Wet pit pumps and appurtenances, including the pump, motor, guide system, monitoring devices and wiring, shall be suitable for operation in the state of Georgia for explosion proof service. Pumps and appurtenances, including the pump, motor, guide system and wiring shall be approved by a national approved testing agency for installation in the state of Georgia for explosion proof service. The system shall be rated for Class 1, Division 1, Group D service as determined by the National Electrical Code and approved by a nationally recognized testing agency (U.L. or F.M.) at the time of bidding of this Project.

2.02 OPERATING CONDITIONS

A. Refer to the Contract Drawings for general arrangements and dimensional limitations. Provide complete submersible pump units designed for the indicated service and free of excessive vibration or hydraulic instability from minimum TDH to shutoff head when operating continuously or intermittently under the conditions herein specified.

B. The operating range of the pump shall include the duty points and shut-off head conditions. The pumps shall be non-overloading throughout the entire pump operating range.

C. All operating points listed in the performance table below, with the exception of the shut-off head condition shall be located within the preferred operating region of pumps as established by pump manufacturer in accordance with ANSI/HI 9.6.3 and as published in the manufacturer's application data for the specific pump model being proposed for this application.

Parameter	Value
Description	Sewage Pumps
Installation Type	Wet Pit
No. of Pumps (total)	2
Equipment Tag Numbers	P-11601, P-11602
Service	Raw Sewage
Min. Shutoff Head, Ft.	100
Solids Handling Capacity, in	3
Discharge Connection Size, in	1 1/4
Suction Connection Size, in	N/A
Max. Pump Speed, rpm	1800
Motor Horsepower Rating, Max.	1
Power Requirements	120V, 1-phase, 60 Hz
Electrical Classification	Class 1 Div.1
Hydraulic Conditions	
Design Point	
Flow, gpm	13
TDH, ft	51
Static Head, ft	3
Minimum NPSHa , ft	30
Minimum Head Condition	
TDH, ft	46

2.03 MATERIALS AND CONSTRUCTION

A. PUMP

1. The pump shall be a vertical rotor, motor driven, solids handling pump of the progressing cavity type with a single mechanical seal. All pump castings shall be cast iron, fully epoxy coated to 8-10 mil Nominal dry thickness, wet applied. The rotor shall be through-hardened, highly polished, precipitation hardened stainless steel. The stator shall be of a specifically compounded ethylene propylene synthetic elastomeric material suitable for domestic wastewater service. Buna-N is not acceptable as a stator material.

2. The grinder shall be placed immediately below the pumping elements and shall be direct-driven by a single, one-piece motor shaft. The grinder impeller (cutter wheel) assembly shall be securely fastened to the pump motor shaft. The shredder ring shall be of the stationary type and the material shall be white cast iron. The grinder shall be capable of reducing all components in normal domestic sewage, including a reasonable amount of "foreign objects," such as paper, wood, plastic, glass, wipes, rubber and the like, to finely-divided particles which will pass freely through the passages of the pump and the 1-1/4" diameter discharge piping.

B. ELECTRIC MOTOR

1. The motor shall be maximum 1 HP, 1800 RPM, 120 Volt 60 Hertz, 1 Phase, capacitor start, ball bearing, air-cooled induction type with Class F installation, low starting current not to exceed 30 amperes. Inherent protection against running overloads or locked rotor conditions for the pump motor shall be provided by the use of an automatic-reset, integral thermal overload protector incorporated into the motor. This motor shall have been specifically listed by Underwriters Laboratories, Inc., for the application.

C. Mechanical Seal

1. Pumps shall be provided with a mechanical shaft seal to prevent leakage between the motor and pump. The seal shall have a stationary ceramic seat and carbon rotating surface with faces precision lapped and held in position by a stainless steel spring. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counter clockwise direction of rotation without damage or loss of seal.

D. TANK

1. Tank shall be either polyethylene or fiberglass construction.
   a. Polyethylene Construction: The tank shall be made of rotational molded polyethylene with high environmental stress cracking resistance. All seams created during tank construction are to be factory tested for leak tightness. The tank wall and bottom must withstand the pressure exerted by saturated soil loading at maximum burial depth. All station components must function normally when exposed to 150 percent of the maximum external soil and hydrostatic pressure.
   b. Fiberglass Construction:
2. The overall basin capacity shall be minimum 400 gallons. The basin shall incorporate a tapered bottom reducing to a diameter to minimize the retained volume.

3. The access way shall include a lockable cover assembly, with vent, providing low profile mounting. The cover shall be aluminum, with a load rating of 300 pounds per square foot. The cover shall have an opening diameter of no less than 30 inches. Access way design and construction shall enable field extension of station height in 6-inch increments without the use of any adhesives or sealants requiring cure time before installation can be completed.

4. The tank shall be furnished with one EPDM grommet fitting to accept a 4.50" OD DWV or Schedule 40 pipe.

   The tank shall have one stainless steel duplex discharge manifold terminating outside the tank wall with a 1-1/4" female NPT pipe thread.

E. DISCHARGE HOSE AND DISCONNECT/VALVE

1. All discharge fittings and piping shall be constructed of polypropylene, EPDM or PVC. The discharge assembly shall include a shut-off valve rated for 200 psi WOG and a quick disconnect feature to simplify installation and pump removal.

F. CHECK VALVE

1. The pump discharge shall be equipped with a factory installed, gravity operated, flapper-type integral check valve built into the discharge piping. The check valve will provide a full-ported passageway when open, and shall introduce a friction loss of less than 6 inches of water at maximum rated flow. Moving parts will be made of a 300 Series stainless steel and fabric reinforced synthetic elastomer. A nonmetallic hinge shall be an integral part of the flapper assembly providing a maximum degree of freedom to assure seating even at a very low back-pressure. The valve body shall be an injection molded thermoplastic resin. The valve shall be rated for continuous operating pressure of 200 psi. Ball-type check valves are unacceptable

G. ELECTRICAL QUICK DISCONNECT

1. The grinder pump core shall include a factory-installed NEMA 6P electrical quick disconnect (EQD) for all power and control functions. The EQD shall require no tools for assembly, seal against water before the electrical connection is made, and include radial seals to assure a watertight seal regardless of tightening torque. Plug-type connections of the power cable onto the pump housing will not be acceptable.

H. Cables

1. Power and control cables shall be suitable for submersible pump applications and shall be indicated by a code or legend permanently embossed on the cable.

2. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices. The outer jacket of the cable shall be oil resistant chloroprene rubber.

3. The motor control cable shall be designed specifically for use with submersible pumps and shall be equal to SUBCAB (Submersible Cable). The cable shall be shielded, multi-conductor type with a chloroprene outer jacket and the tinned copper conductors insulated with ethylene-propylene rubber. The conductors shall be arranged in twisted pairs. The cable shall be rated for 750 Volts and 90°C (194°F) with a 40°C (104°F) ambient temperature and shall be approved by Factory Mutual (FM). The cable length shall be

adequate to reach the junction box without the need for splices.

4. The cable entry sealing fitting shall relieve stress on conductors and provide a watertight and submersible seal, without the use of sealing compounds and without the application of specific torques to connectors. The conductors shall connect to a terminal board, which shall be provided with a moisture tight seal between the cable entry junction chamber and the motor.

5. Power and Control Cable Protection System: The pump supplier shall provide a support and protection system for the power and control cables for each of the pumps supplied. This system shall be a part of, and integrated into each pump unit. The supplier shall assume full responsibility for its function and provide a functional guarantee, as detailed below. The system shall consist of the following components and functions:
   a. The pump supplier shall guarantee that this system functions in an automatic and effortless way while a pump is lifted or installed, that no wear, tear or damage be inflicted to either of the flexible electrical cables. Any cable wear or operational problems that occur within a 5-year period shall be repaired and improved by the pump supplier without cost to the Owner.
   b. Appropriate cable support brackets shall be supplied by the pump supplier and permanently installed by the contractor at the deck level to provide support and strain relief function.

2.04 CONTROLS

A. Level monitoring

1. Wet well liquid level shall be accomplished by monitoring the pressure changes in an air column connected to a pressure switch. The air column shall be suitable for use in wastewater and shall have no moving parts in direct contact with the wastewater. Furnish a factory installed equalizer diaphragm that compensates for any atmospheric pressure or temperature changes. Tube or piping runs outside of the station tank or into tank-mounted junction boxes providing pressure switch equalization will not be permitted.

2. All fasteners throughout the assembly shall be 300 Series stainless steel. High-level sensing will be accomplished in the manner detailed above by a separate air column sensor and pressure switch of the same type. Closure of the high-level sensing device will energize an alarm circuit as well as a redundant pump-on circuit. For increased reliability, pump ON/OFF and high-level alarm functions shall not be controlled by the same switch.

B. Pump Control Panel

1. Furnish a fiberglass NEMA 4X, UL listed control and alarm panel enclosure suitable for wall or pole mounting.

2. The panel shall contain one 15-amp single pole circuit breaker for the alarm circuit, and shall contain one 15-amp double pole circuit breaker per pump unit for the power circuit.

3. The control/alarm panel(s) shall include the following features:
   a. Corrosion-proof fiberglass enclosure
   b. NEMA 4X rated enclosure
   c. Lockable latch
   d. Circuit breakers

e. Terminal blocks & ground lugs
f. Alarm Dry Contacts
g. Lead/Lag indicator lights
h. Alarm indicator lights
i. Run indicator lights
j. Manual Push-to-Run

4. The high-level alarm system shall operate as follows:
   a. The pumps will go into alarm mode if either pump alarm switch closes. During the initial alarm mode both pumps will run and the alarm light and horn will be delayed for 3-1/2 minutes. If the station is still in high-level alarm after 3-1/2 minutes the light and horn will be activated.
   b. Visual alarm remains illuminated until the sewage level in the wet well drops below the "off" setting of the alarm switch for both pumps. The visual alarm shall be inside a red fluted lens at least 2-5/8" in diameter and 1-11/16 in height. The visual alarm shall be externally mounted on the enclosure in such a manner to maintain NEMA 4X rating.
   c. The audible alarm shall be externally mounted on the enclosure, capable of 93 dB @ 2 feet. The audible alarm shall be capable of being deactivated by depressing a push-type switch (push-to-silence button).
5. Service Equipment/Main Service Disconnect Breaker – A separate, internal breaker rated and approved for use as "service equipment" and acts as a main service disconnect of the grinder pump station shall be provided.
6. Remote Alarm – A separate alarm signal shall be provided for remote monitoring. The Remote
7. Run-time/Hour Meter – Seperate run-time / hour meter to display the total run-time or operation time for each pump unit shall be provided.
8. Event/Cycle Counter – An event / cycle counter to display the number of operations of each pump unit shall be provided.

2.05 SPECIAL OPERATING CONDITIONS

A. Under normal conditions the pump station may not receive adequate flow to maintain proper operability due to long periods with minimal or no flow. To avoid these conditions, a solenoid operated valve will be periodically opened with discharge into the wet well to exercise the pumps and to flush the system. Provide control logic in the main control panel to open/close this valve with each 24 hour period that allows two cycles, adjustable between 0 and 15 minutes, each. This information will be submitted with the shop drawings as specified above.

2.06 FACTORY INSPECTION AND TESTING

A. The pump supplier shall conduct full scale, full range factory performance tests as specified herein. Tests shall be conducted in accordance with the latest edition of the Submersible Pump Test Standard, ANSI/HI 11.6

B. Each pump shall be tested for performance at the factory as specified herein.

C. Testing shall include but not limited to the following:

1. Motor rating and electrical connections shall first be checked for compliance to specific requirements and shall be visually inspected to certify no defects.
2. Conduct mechanical and electrical motor integrity tests in accordance with ANSI/HI 11.6.
3. Motor and cable insulation test for moisture content or insulation defects.
4. After a submerged test run of 30 minutes, item 2 shall be retested.
5. If any deviation of above is found, the pump shall be rejected.

D. Pump Tests

1. Run pump at full speed rating point for 60 minutes prior to start of any testing.
2. Full Speed Tests: Test pump at the specified conditions and record and tabulate readings of flow, differential pressure, BHP, efficiency, $NPSH_R$, input kW, voltage, frequency, and power factor for each test point.
3. Tests shall be carried out at each of the operating points listed in Article 2.02 including the Design Point, Minimum Flow/Maximum Head Point and Maximum Flow Minimum Head Point.
4. Operate each pump for not less than one hour and take readings to verify that the pump will operate as specified without cavitation or excessive vibration and with no more than the specified NPSHA, where such is stated.
5. Run a test with each pump operating with its minimum recommended submergence.
6. Testing of pumps at specified points shall be accomplished with the pumps submerged for wet pit pumps.
7. In the event that specified tests indicates that a pump or motor does not meet specifications, The Owner reserves the right to require witnessed re-testing tests for that pump and motor at no additional cost to the Owner.
8. Furnish certified performance tests as specified for all pumps.
9. Furnish a certification that the pump horsepower demand did not exceed the rated motor horsepower beyond a 1.0 service rating at any of the test points.

2.07 FACTORY PAINTING

A. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied coating in accordance with Specification Section 09900.

B. The pump manufacturer shall provide extra finish coat similar to the factory applied finish coating for Contractor touch up painting in the field.

2.08 SPARE PARTS

A. The pump supplier shall provide a list of recommended spare parts and shall indicate what items are stocked and which items are special orders. .

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment Installation: All equipment shall be installed in accordance with approved shop drawings and manufacturer's recommendations.

B. Anchorage: Stainless steel anchor bolts, nuts and washers, as well as any templates necessary for setting the anchorage, shall be furnished by the equipment manufacturer. Placement of the anchor bolts shall be done by the Contractor from certified dimension shop drawings supplied by the equipment manufacturer.

C. Leveling and Grouting

1. Level and align pump and guide bars in accordance with the respective manufacturer's published data.
2. Provide concrete mounting base as required in accordance with Specification 03000 and equipment manufacturer's recommendations.

3.02 PAINTING

A. After installation and approved field testing by the Engineer, the Contractor shall apply touch-up paint to all scratched, abraded and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.03 MANUFACTURER SERVICES

A. Furnish the services of trained service technician, certified by the manufacturer, to service the type of equipment specified in accordance with the requirements of the General Conditions of the Contract Documents and as specified herein.

B. The service representative must have a minimum of two years of experience supervising the installation and inspection of the type and size of equipment specified.

Provide assistance to the Contractor during equipment installation including, but not limited to observation, guidance, instruction of contractor's assembly, erection, installation or application procedures, inspection and checking of installation and furnishing of written approval of installation.

C. Assistance during functional and performance testing and startup demonstration, and product acceptance by the Owner.

D. Training of Owner's personnel in the operation and maintenance of equipment as required.

E. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.04 FIELD TESTING

A. The Contractor shall obtain water for field testing of pumps from a source approved by the Owner. The Contractor shall be responsible, at no additional cost to the Owner for provision of temporary piping, pumping, and other ancillary equipment necessary for delivery of water to the pump station for pump testing purposes. Test water shall be disposed of as directed by the Owner.

B. Contractor shall provide all labor, piping, equipment, portable flow meters, calibrated gauges or calibrated test gauges, and materials for conducting tests. Tests will not be acceptable if equipment calibration is not within 60 days of the field testing.

C. The pumps shall be tested at start-up by the pump supplier or its authorized representative. The pump supplier shall provide a formal test procedure and forms for recording the test data.

D. Each pump system shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, damaging cavitation, or overheating of bearings and to demonstrate the indicated head, flow, and efficiency at the design rating point.

E. Test removal and replacement of all pumps to prove the pumps and guide systems are properly installed and aligned.

F. Pump control devices shall be tested and adjusted in the field by the manufacturer service representative.

3.05 SERVICE CAPABILITY

A. Service Facility and Maintenance Agreement

1. A scheduled 5-year preventative maintenance and service agreement shall be included in the manufacturer's price with the supply of pumps. Each pump shall be inspected once per year, or every 5,000 hours, whichever comes first. The inspection shall consist of a complete and thorough mechanical and electrical check of each pump followed by a complete report of the findings. This agreement includes all labor and materials used for the inspections outlined by the maintenance agreement for each of the pumps for the full 5-year period and assures that all requirements for fulfillment of the pump warranty have been met.
2. The pump supplier shall be responsible for raising the pumps from the wet well; servicing the pumps and lowering the pumps back down into the wet well as required for the inspections.

END OF SECTION 11600

SECTION 13000
INSTRUMENTATION AND CONTROLS – GENERAL PROVISIONS

PART 1 - GENERAL

1.01 DOCUMENTS

A. Drawings, specifications and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 13.

B. "Division 11", as used herein, refers to all project Equipment Section Specifications (11XXX).

C. "Division 13", as used herein, refers to all project Special Construction Section Specifications (13XXX).

D. Division 13", as used herein, refers to all project Process Instrumentation and Controls Section Specifications (13XXX).

E. "Division 15", as used herein, refers to all project Mechanical Section Specifications (15XXX).

F. "Division 16", as used herein, refers to all project Electrical Section Specifications (16XXX).

G. The requirements of this Section apply to the entire Scope of Work including that shown on the Drawings, in the Division 13 Section Specifications, and in the General and Supplementary Conditions, and Division 1 Specifications

1.02 DEFINITIONS

A. "Drawings" or "Contract Drawings", as used herein, refer to the project contract drawings.

B. "Specifications" or "Contract Specifications", as used herein, refer to the project contract specifications.

C. "Contractor", as used herein, refers to the General Contractor (including his sub-contractors and his instrument/electrical/etc equipment manufacturers, and suppliers who provide his equipment), who has overall responsibility to furnish and install the "Scope of Work", as described herein and per the Contract Documents.

D. "Instrumentation and Controls (I&C) Subcontractor", as used herein, refers to a sub-contractor to the General Contractor who has primary responsibility to furnish and install the Instrumentation and Controls "Scope of Work", as described herein and per the Contract Documents.

E. "Control Systems Subcontractor", as used herein, refers to a sub-contractor to the General Contractor who has primary responsibility to furnish and install the Process Control System hardware and software (Control System can be Programmable Controller (PLC), Distributed Control System (DCS), and/or Personal Computer (PC) based system as noted in the associated project specifications) associated with the overall Instrumentation and Controls "Scope of Work", as described herein and per the Contract Documents.

F. "Telemetry System Subcontractor", as used herein, refers to a sub-contractor to the General Contractor who has primary responsibility to furnish and install the Telemetry System associated with the overall Instrumentation and Controls "Scope of Work", as described herein and per the Contract Documents.

G. Process and Instrument Diagram (P& ID) or Connections Diagram: A process or flow diagram is a conceptual diagram of the functional interrelationship of subsystems in block or pictorial form. Process equipment such as machinery is shown for proper understanding

H. Schematic Diagram or Elementary Diagram: A schematic or elementary diagram is one that shows all circuits and device elements of a system or piece of equipment and its associated apparatus or any clearly defined functional portion thereof. Such a diagram emphasizes the device elements of a circuit and their functions as distinguished from the physical arrangement of the conductors, devices or elements of a circuit system

I. Wiring Diagram or Connection Diagram: A wiring or connection diagram is one that locates and identifies electrical devices, terminals, and interconnecting wiring in an assembly. This diagram shall be in a form showing interconnecting wiring by lines or indicating interconnecting wiring only be terminal designations

J. Interconnecting Diagram: An interconnection diagram is one that shows only the external connections between controllers, control panels, and associated machinery and equipment

K. Dimension or Outline Drawing: A dimension or outline drawing (base plan, floor plan, and so forth) is one that shows the physical space and mounting requirements of a piece of equipment. It shall be permitted to also indicate ventilation requirements and space provided for connections or the location to which connections are to be made

L. One-Line Diagram (Single-Line): A one-line or single-line diagram is one that shows, by means of single lines and graphic symbols, the course of an electrical circuit or circuits and the component devices or parts used therein. Physical relationships are usually disregarded

M. Logic Diagram: A logic diagram is a particular form of one-line or single-line diagram of a logic circuit using logic symbols

N. Block Diagram: A block diagram is made up of a group of interconnected blocks, each of which represents a device or subsystem

O. Loop Diagram: A loop diagram is a collection of all components of an individual instrumentation system, or loop, showing the field, junction, panel rear and front connection points and all associated equipment

P. Wireless Connection Diagram: The general physical arrangement of devices in control equipment and connections between these devices, terminals, and terminal boards for outgoing connections to external apparatus. Connections are shown in tabular form and not by lines. An elementary (or schematic) diagram may be included in the connection diagram

1.03 SCOPE OF WORK

A. The Instrumentation and Control System work for the project shall consist of new panel work, modification of existing panels (if required), field instrumentation and components, PLC based

Control System at the project site, system communication links, remote telemetry communication equipment (as required), and a remote Distributed Control System (DCS) monitoring link at the existing RM Clayton WRC. A new PLC based Control System for the Liddell Drive Equalization Facility and associated equipment at the project site shall be furnished under the Division 13 Specifications including Programmable Controller Specification 13400. A remote communication and monitoring link to the project site from the RM Clayton WRC will require modifications to the existing Foxboro DCS System at RM Clayton and shall be provided and configured by the DCS system integrator has required by the Division 13 Contract Drawings [P&ID Drawings (I-101, I-102, I-103, I-104, I-106, I-107, and I-108) and Control System Network Drawing (I-002)] and Specifications including the DCS Specification 13500.

B. Instrumentation and Controls required for the Project: The work shall include providing new PLC hardware and configuration for the project site at Liddell Drive Equalization Facility, Local Control Panels per Specification 13200, new DCS Communication Gateway and associated configuration at the RM Clayton WRC, instrumentation and controls equipment, configuration, and startup associated with the process design work for this project. A summary of this work is as follows:

1. New Level Transmitters, low level switches, and other controls at the Diversion Facility Wet Wells associated with the Project.
2. New Local Control Panel including PLC Based Control System for the Diversion Facility located in the associated Electrical Building. New Communication link(s) to Remote Monitoring Sites.
3. New Level Monitoring Panel for each Diversion Wet Well (two) located in the Diversion Facility Electrical Building. New Gas Monitoring Panel located at each Diversion Wet Well (two). New Gas Monitors for the Diversion and Equalization Facility Odor Control Systems. Loss of Ventilation System alarm panels for the Diversion and Equalization Facility.
4. New Magnetic Flow meter on the discharge of each set of Diversion Pumps (one per Wet Well).
5. Monitoring and control of Sluice Gates at each Diversion Structure. Monitoring and control of Sluice Gates at the Inlet of each Diversion Wet Well. Monitoring and control of sludge grinders (two) at each Diversion Wet Well.
6. New Redundant Flow Transmitters at the Flow Metering Manhole associated with Diversion Facility.
7. New remote monitoring of new redundant Level Transmitters at the existing Level Monitoring Manhole located near the Cross Creek Housing Area. (this manhole is also referred to as the Peachtree Creek Trunk Relief Manhole (PCTRM) MH 23180203601).
8. New Local Control Panel including PLC Based Control System for the Equalization Facility located in the associated Electrical Building. New Communication link(s) to Remote Monitoring Sites.
9. New Level transmitter for the Equalization Tank. Monitoring and control of motorized isolation valves at the Equalization Tank. New Capacitance Level Switch for high high Equalization Tank protection and alarming. New discharge high pressure switches for the Jet Mixing Pumps. New level switch for the Cheshire Bridge Junction Box.
10. Monitoring and Control of Motorized Valves at the Equalization Tank and Equalized Flow Return System and Equalized Flow Return Isolation Valve at Diversion Pumps. Monitoring

and Control of Motorized Flushing Water Isolation Valves at the Equalization Tank for the end of Relief Event cleanout flushing sequence.

11. New Magnetic Flow meters on the discharge of each Equalized Flow Return Pump. New thermal low flow switches for monitoring Ventilation air flow from the Diversion Valve Room and EQ Jet Mixing Pump Station.

12. Monitoring and Control of motors associated with the Sludge Grinder Local Control Panels; Diversion Wet Well Drainage and Diversion Pumps; Jet Mixing System Pumps; Equalized Flow Return Pumps; and Equalization Tank Drainage Pumps.

13. New DCS Communication Gateway at the RM Clayton WRC for remote monitoring and control of the PLC based Control System located in the Local Control Panel at the project site.

C. Instrumentation and Controls provided under this contract shall provide a complete and fully functional process control and monitoring system as described in the Contract Drawings and Specifications including functionality shown on the P&ID Drawings (I-101, I-102, I-103, I-104, I-105, I-106, I-107, I-108), Control System Network Drawing(s) (I-102), HVAC Air Flow Diagrams (as required) and per HVAC Control Specification 15950 (as required). Control Logic Descriptions shall be provided under Specification 13150. An Instrument Index for non-vendor furnished instrumentation shall be provided under Specification 13100. A PLC I/O List shall be provided under Specification 13120.

D. Instrumentation and Controls design may include the implementation of Virtual I/O Communication between the project's Control System and various non-Division 13 control packages that may contain other electronic controls like programmable controllers, embedded microprocessor based controllers, or vendor specific proprietary control systems. Required Virtual I/O Communication Links shall be shown on the project's Process and Instrumentation Diagrams (P&ID) and/or described in the project's logic descriptions. Contractor is required to investigate all Virtual I/O Links and provide sufficient hardware, software, and configuration services to fully implement the required virtual communication so as to complete the functionality of the project's control system and to implement the intent of the additional functionality both in terms of monitoring and control that the Owner requires to properly operate his facility as described in the Contract Documents. Contractor is fully responsible to recommend those Virtual I/O points that provides for a fully functional and complete control system. Scope of work may include interfacing with the Engineer and/or Owner to insure that the Contractor proposed list of virtual I/O points is sufficient to provide the functionality required in the Contract documents.

E. Furnish all labor, supervision, services, materials, equipment, documentation, and incidentals required to make ready for use a fully integrated, fully documented, tested, and completely functional instrumentation and control system as shown on the Drawings and as specified herein. Equipment shall be furnished, fabricated, assembled, installed, and placed in proper operating condition in full conformity with the detailed Drawings, Specifications, engineering data, instructions and recommendations of the equipment manufacturer as approved by the Engineer.

F. The Instrumentation and Controls provided under this Division shall be designed and coordinated to ensure complete and fully functional operation of all project (furnished under the current Contract) related equipment and materials as furnished by the Instrumentation and Controls Subcontractor as well as with other equipment and materials provided by others under sections of these Division 13 Specifications, and with other equipment and materials provide by others under related Contract Specifications, and with related existing equipment.

G. To the maximum extent possible, a single Engineer-approved Instrumentation and Controls Subcontractor shall furnish all labor, services, materials, documentations, and equipment as specified in this specification and associated Division 13 specifications.

H. Should the project's Control System (PLC, DCS, SCADA and/or Telemetry control systems) design, configuration, and/or other services be performed by parties other than the Instrumentation and Controls Subcontractor, the Instrumentation and Controls Subcontractor shall be the primary party responsibility to coordinate the design, implementation, and testing with said other parties to ensure a complete and fully functional process instrumentation and control system.

I. The work shall include furnishing, coordinating, installing, and testing the following:

1. All instrumentation and controls, as noted on contract drawings and not furnished by others, including but not limited to those instruments and controls shown on the project's Process &

   Instrumentation Drawings (P&IDs), Instrument List(s), and Control System Architecture Drawing(s) and as specified in all other Sections of the Division 13 Specifications.

2. All Auxiliary devices and accessories, such as signal isolators, transducers or relays, necessary to provide for or to ensure the complete functionality and safe operation of the instrumentation and controls, and to allow interfacing to and/or control of existing equipment and/or equipment provided by other suppliers under other sections of these Contract Specifications, shall be included whether or not said signal isolators, auxiliary devices, or accessories are shown on the Contract Drawings.

3. Instrument mounting pipe stands and brackets, unless expressly supplied by the General Contractor and/or one of his other subcontractors, shall be provided for all instruments not designated as being process or equipment mounted or determined to be located in existing or new control panels. Provide sufficient materials for all instrumentation and controls supplied under this Division; and for all loose vendor-furnished instrumentation and controls as provided by other suppliers under other Sections of these Specifications; and for those existing instrumentation and controls that are determined to have to be relocated or remounted as part of this Contract.

4. Unless otherwise noted, the installation of process-mounted instruments shall be performed by the General Contractor and/or Mechanical Contractor. The Instrumentation and Controls Subcontractor shall provide guidance to the General Contractor and/or Mechanical Contractor to ensure the proper installation and safe operation of the all supplied instrumentation and controls in full conformity with detailed Drawings, Specifications, engineering data, instructions and recommendations of the instrument/equipment manufacturer as approved by the Engineer.

5. Unless otherwise noted, the installation of field-mounted instruments shall be performed by the General Contractor and/or Electrical Contractor. The Process Instrumentation and Controls Subcontractor shall provide guidance to the General Contractor and/or Electrical Contractor to ensure the proper installation and safe operation of the all supplied instrumentation and controls in full conformity with detailed Drawings, Specifications, engineering data, instructions and recommendations of the instrument/equipment manufacturer as approved by the Engineer.

6. Unless otherwise noted, the connection of instrument air and process measurements to all process instrumentation and controls shall be performed by the General Contractor and/or Mechanical Contractor. The Instrumentation and Controls Subcontractor shall provide

guidance to the General Contractor and/or Mechanical Contractor to ensure the proper installation and safe operation of the all supplied instrumentation and controls in full conformity with detailed Drawings, Specifications, engineering data, instructions and recommendations of the equipment manufacturer as approved by the Engineer.

7. Unless otherwise noted, the field wiring (including pulling of specialty cables supplied under Division 13) of all process instrumentation and controls shall be performed by the General Contractor and/or Electrical Contractor as noted in the Contract Specifications. The Instrumentation and Controls Subcontractor shall supply Instrumentation Society of America (ISA) –ISA Standard S5 - style "Loop Sheets" showing detailed wiring terminations to assist the General Contractor and/or Electrical Contractor in the performance of said field wiring and terminations. Field connections to Control System hardware or Telemetry System hardware shall be fully documented by the Instrumentation and Controls Subcontractor (or separate Control System Subcontractor or Telemetry System Subcontractor) utilizing Engineer-approved custom wiring drawings and/or fully annotated mark-ups of standard control system vendor documentation.

8. Termination and testing of Fiber Optic Cables and/or Control System communication cabling shall be performed by the Instrumentation and Controls Subcontractor and/or Control System Subcontractor. Connection and/or termination of Control System hardware interconnecting cabling shall be performed by the Instrumentation and Controls Subcontractor and/or Control System Subcontractor. Connection and/or termination of Telemetry System hardware interconnecting cabling shall be performed by the Instrumentation and Controls Subcontractor and/or Telemetry System Subcontractor.

9. Unless otherwise noted, the installation of all control panels, I/O Cabinets, controllers, etc. furnished under this Division shall be performed by the General Contractor and/or Electrical Contractor. The party responsible for supplying said control panels or cabinets or control devices (i.e. Instrumentation and Controls Subcontractor or Telemetry System Subcontractor) shall be responsible to certify the proper installation and operation of all supplied equipment.

10. The Instrumentation and Controls Subcontractor and/or Control System Subcontractor and/or Telemetry System Subcontractor shall furnish all non-standard specialty instrumentation and control system cables associated with equipment provided under these Division 13 specifications. A composite list and associated cut sheets of all of these cables to be furnished shall be included with the associated Instrumentation and Controls Submittals for Engineer review and Approval. The cable supplier shall coordinate with the General Contractor and/or Electrical Subcontractor to ensure that sufficient cable lengths are provided to properly complete the equipment installation and connections.

11. The Instrumentation and Controls Subcontractor and/or Control System Subcontractor and/or Telemetry System Subcontractor shall coordinate with General Contractor and/or Electrical Subcontractor to ensure that all instrumentation and controls furnished under this Contract are properly grounded and protected against lightning and/or power surges as noted on the Contract Drawings and as noted on the Contract Specifications (including Division 16 and Division 13 specifications).

12. The Instrumentation and Controls Subcontractor and/or Control System Subcontractor and/or Telemetry System Subcontractor shall be responsible for checking out grounding and other safe operation concerns for all supplied control panels, PLC hardware, and other sensitive electrical or electronic control system equipment prior to energization. All Control System and/or Telemetry System I/O should be 100% "real world" simulated from I/O card to/from the panel mounted devices or external terminal blocks. In this regard, all control

panels should have a 100 % point to point wiring checkout prior to being shipped from panel fabricator and should be inspected once placed by Contractor as being ready for construction (no shipping damage, internal wiring okay, grounding applied properly). Grounding of all Control System and/or Telemetry System Cabinets shall be verified by Subcontractor prior to allowing any Contractor or Subcontractor to energize any temporary or permanent power circuits to said Cabinets, power supplies, or programming terminals.

13. The Instrumentation and Controls Subcontractor and/or Control System Subcontractor and/or Telemetry System Subcontractor shall furnish new or rework existing control panels and/or control system cabinets and/or telemetry system cabinets required to complete the instrumentation and controls as shown on the Contract Drawings and Contract Specifications.

14. Unless specified otherwise, the Instrumentation and Controls Subcontractor shall review the shop drawings of all equipment including the shopping drawings of equipment with electrical "field wiring" connections furnished under all divisions of these Contract Specifications. Unless Engineer and Owner approves use of vendor furnished wiring drawings, the Instrumentation and Controls Subcontractor shall provide ISA (ISA Standard S5) style "Loop Sheets" showing detailed "field wiring" terminations of all instrumentation and controls (whether furnished by the Instrumentation and Controls Subcontractor or whether furnished by others) that connect to control panels, control systems (Programmable Controller (PLC), Distributed Control System (DCS), and/or Personal Computer (PC) based systems), and telemetry systems related to the Contract Drawings and Contract Specifications. Where applicable, the Instrumentation and Controls Subcontractor shall design electrical interconnections per manufacturer's requirements. This includes, but is not limited to, devices that are parts of "packages" but which are shipped separately and require field wiring connections.

15. Unless specified otherwise, the Instrumentation and Controls Subcontractor and/or Control System Subcontractor and/or Telemetry System Subcontractor shall identify terminals and prepare custom interconnect drawings or cabling/wiring tables, if necessary, or fully annotate vendor standard drawings to facilitate interconnection of all Control System and/or all Telemetry System components.

16. Unless specified otherwise, the Instrumentation and Controls Subcontractor shall customized training for the maintenance and operations of all instrumentation and controls provided under these Division 13 Specifications.

17. Disconnection and storage prior to turnover to owner of all existing instrumentation and controls that will be taken out of service as part of this Contract, where required.

J. It is the intent of these Specifications that the instrumentation and controls shall be complete and suitable in every way for the service required. All materials and all work which may be reasonably implied as being incidental to the work of this Section or other applicable sections shall be furnished at no extra cost.

K. Substitutions of the functions or type of equipment specified will not be acceptable without written approval of the Engineer. In order to ensure the interchangeability of parts, the maintenance of quality, the ease of interfacing between the various subsystems, and the establishment of minimums with regard to ranges and accuracy, strict compliance with the above requirements shall be maintained.

L. To facilitate the Owner's future operation and maintenance, all furnished products shall be of the same major instrumentation manufacturer, with control panel mounted devices of the same type

and model as far as possible. For existing facilities, every effort shall be made to supply equipment of the same major manufacturer and model as those predominately found at the Owners facility unless written approval is obtained from the Owner and/or Engineer.

M. All labor, supervision, services, materials, equipment, documentation, and incidentals necessary to achieve the monitoring and control functions described herein shall be provided in a timely manner such that the monitoring and control functions are available when the equipment is ready to be placed into service.

N. Where applicable, the contractor or his authorized representatives shall, before preparing his proposal, visit all areas of the existing site, buildings and structures in which work under this section is to be performed and inspect carefully the present installation. The submission of the proposal by this contractor shall be considered evidence that he or his representative has visited the buildings and noted the locations and conditions under which the work will be performed and that he takes full responsibility for a complete knowledge of all factors governing his work.

O. Where applicable, all process and/or control system operation interruptions affecting existing equipment and plant operations shall be at the Owner's convenience with at least 72 hours (minimum) notice. Each interruption shall have prior approval.

P. Where applicable, the Contractor and his subcontractors shall maintain the existing facility in operation at all times.

Q. The work shall include complete testing of all equipment and wiring at the completion of work and assistance in facilitating minor corrective changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

R. Unless otherwise negotiated with the Owner, Contractor and his subcontractors shall provide their own temporary power for miscellaneous power (drills, pumps, etc.). No existing facility panelboard circuits shall be used. Anything temporarily added, shall be removed at job completion.

S. Complete coordination with other contractors and sub-contractors. The Instrumentation and Controls Subcontractor shall coordinate with all other Contractor's and sub-contractor's equipment submittals and obtain all relevant submittals prior to startup commissioning and testing.

1.04 REFERENCE STANDARDS

A. The instrumentation and controls engineering design, equipment, materials, and installation shall be provided in accordance with the Instrumentation Society of America (ISA) Standards and Recommended Practices, with the National Electrical Code (NEC), and with the latest edition of all codes and standards of the following organizations:

1. American National Standards Institute (ANSI), including (but not limited to):
   a. ANSI B16.5 Pipe Flanges and Flanged Fittings
   b. ANSI C2 - National Electrical Safety Code
   c. ANSI / IEEE C37.90: Guide for Surge Withstand Capability Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
   d. ANSI X3.5 - Flowchart Symbols and Their Usage in Information Processing.

2. American Society of Mechanical Engineers (ASME), including (but not limited to):
   a. ASME / ANSI B16.36 - Orifice Flanges
   b. ASME / ANSI B16.5 - Pipe Flanges and Flanged Fittings
   c. ASME "Fluid Meters Their Theory And Application"
3. American Society for Testing and Materials (ASTM), including (but not limited to): ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
4. American Petroleum Institute (API), including (but not limited to): API Recommended Practice 550 – Instrumentation Installations
5. Building Officials and Code Administrators International, Inc. (BOCA)
6. Electronics Industries Association (EIA)
7. Factory Mutual (FM)
8. Federal Communications Commission (FCC), including (but not limited to): FCC Regulations Part 15 concerning radio frequency transmission and interference
9. Institute of Electrical and Electronics Engineers (IEEE), including (but not limited to):
   a. IEEE Standard 730 - Standard for Software Quality Assurance Plans.
   b. IEEE Standard C62.22- Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.
   c. IEEE Standard C62.36 - Test Methods for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits.
   d. IEEE Recommended Practice C62.41- Characteristics of Surges in Low Voltage AC Power Circuits.
   e. IEEE Recommended Practice C62.45- Guide on Surge Testing for Equipment connected to Low Voltage AC Power Circuits.
   f. IEEE Standard C62.64 - Specifications for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits.
10. Instrument Society of America (ISA), including (but not limited to):
   a. ISA Standard S5.1 - Instrumentation Symbols and Identification
   b. ISA Standard S5.2 - Binary Logic Diagrams for Process Operations
   c. ISA Standard S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
   d. ISA Standard S5.4 - Instrument Loop Diagrams
   e. ISA Standard S5.5 – Graphic Symbols for Process Displays
   f. ISA Standard 18.1 – Annunicator Sequences and Specifications
   g. ISA Standard S20 - Instrument Spec Sheets
   h. ANSI / ISA–S12.1.01–1999 - Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations
   i. ISA RP7.3 – Quality Standard for Instrument Air
   j. ISA RP12.4- Pressurized Enclosures
   k. ANSI / ISA 12.06.01 – Wiring Practices for Hazardous (Classified) Locations – Instrumentation Part 1: Intrinsic Safety.
   l. ANSI / ISA TR12.06.01 – Electrical Equipment in a Class I, Division 2/Zone 2Hazardous Location.

m. ANSI/ISA–S12.12–1994 - Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations

11. International Conference of Building Officials (ICBO)

12. National Electrical Manufacturers Association (NEMA), including (but not limited to):
    a. AB-3 – Molded Case Circuit Breakers and their Applications
    b. ICS 1 - Industrial Control and Systems: General Requirements.
    c. ICS 2 - Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More than 2,000 Volts AC or 750 Volts DC.
    d. ICS 3 - Industrial Control and Systems: Factory Built Assemblies
    e. ICS 4 - Industrial Control and Systems: Terminal Blocks.
    f. ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
    g. ICS 6 - Industrial Control and Systems: Enclosures.
    h. ICS 19 - Industrial Control and Systems: Diagrams, Device Designations, and Symbols.
    i. LS-1 - Low Voltage Surge Protection Devices.
    j. NEMA Standard 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).

13. National Fire Protection Association (NFPA), including (but not limited to):
    a. NFPA 70 - National Electrical Code (NEC)
    b. NFPA 72 - National Fire Alarm Code
    c. NFPA 79 - Electrical Standard for Industrial Machinery
    d. NFPA 101 - Life Safety Code
    e. NFPA 110 - Emergency and Standby Power Systems
    f. NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment
    g. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

14. Occupational Safety and Health Act (OSHA)

15. Scientific Apparatus Makers Association (SAMA)

16. Southern Building Code Congress International (SBCCI): Standard Building Code (SBC)

17. Underwriter's Laboratories (UL), including (but not limited to):
    a. UL 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
    b. UL 489 – (NEMA AB-1) – Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.
    c. UL 497 – Standard for Protectors for Paired Conductor Communications Circuits.
    d. UL 497B – Safety Protectors for Data Communications and Fire Alarm Circuits.
    e. UL 508 – Industrial Control Equipment.
    f. UL 698 – Industrial Control Equipment for use in hazardous areas.
    g. UL 943 – Ground Fault Circuit Interrupters.
    h. UL 1077 – Standard for Supplementary Protectors for Use in Electrical Equipment.
    i. UL 1283 - Standard for Electromagnetic Interference Filters.
    j. UL 1363 – Standard for Relocatable Power Taps.

k. UL 1449 – Standard for Transient Voltage Surge Suppressors.

l. UL 1604 -Standard for Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations.

18. Uniform Building Code (UBC)

19. All applicable state and local codes, amendments, regulations and practices.

20. Appropriate Authorities Having Jurisdiction.

B. Where codes and/or standards conflict, the most conservative document shall be followed.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The Instrumentation and Controls Subcontractor shall perform all work necessary to complete his portion of the "Scope of Work" specified in this Division. The Instrumentation and Controls Subcontractor does not have to be the same supplier as the Control System Subcontractor nor Telemetry System Subcontractor as specified in separate sections of this contract. For this project, the providing of the Remote Communication and Monitoring Gateway at the existing RM Clayton WRC will be provided by DCS Configuration Subcontractor as defined under Specification 13500.

B. The Instrumentation and Controls Subcontractor shall maintain a fully equipped office/production facility with full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting, and testing the instrumentation and control system specified herein. Qualified repair personnel shall be available and capable of reaching the facility within a 24 hour period.

C. Actual installation of the equipment and materials specified by this Division need not be performed by employees of the Instrumentation and Controls Subcontractor; however, the Instrumentation and Controls Subcontractor shall be responsible for the on-site technical supervision of the installation.

D. The Instrumentation and Controls Subcontractor shall furnish equipment and materials, which shall be the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.

E. The General Contractor must name his/her proposed Instrumentation and Controls Subcontractor and Control System Subcontractor(s) and Telemetry System Subcontractors in the bid documents. These subcontractors shall be experienced and fully qualified to perform their individual scopes of work as specified in the Contract. Resumes, including description of previous related project experience, of all proposed qualified individuals with each Subcontractor that are actually available to perform work associated with their scopes of work shall be included with the bid documents. Substitution of subcontractor personnel during the Contract period without written approval of the Engineer is not permitted. Failure to document sufficient personnel with appropriate experience and qualifications to perform the work proposed is sufficient grounds to disqualify the Contractor and/or Subcontractors from performing or completing the "Scope of Work" associated with this Division.

F. Subcontractor Qualifications:

1. General
   a. The specified control system and instrumentation integration including panel building, instrument calibration, testing, start-up, operational testing, and training shall be performed by a Systems Integrator staffed with qualified personnel, possessing necessary equipment and experience in performing similar project installations.
   b. The control system components shall, as far as practical, be of one manufacturer.
   c. The components, modules, devices, and control system equipment shall be recognized industrial quality products. Recognized commercial or office grade products are prohibited.
   d. The overall system performance shall be demonstrated to and accepted by Owner.
   e. The application software packages shall be latest versions available, or compatible with existing software currently in use.

2. Systems Integrator Qualifications:
   a. The following Systems Integrators are pre-qualified to perform the work specified in Division 17 without the need to provide Evidence of Experience:
      i) Control Instruments Incorporated (C2I), Atlanta, GA
      ii) Transdyn, Duluth, GA
      iii) MR Systems, Norcross, GA
      iv) Revere Controls, Birmingham, AL
      v) Turbitrol
      vi) As approved per requirements of this Section or as modified by any Addendums.
   b. Contractor-proposed Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:
      i) Submit evidence of experience in performing three similar successful projects in the last five years with one project currently in progress or competed within the last two years.
      ii) Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.
      iii) Submit organization chart and resumes for proposed project personnel.
      iv) Submit Training and Certification information. Completion of the following training courses or appropriate portions thereof or possession of the following certifications included with the Systems Integrator's personnel experience requirements described above:
         a) Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
         b) Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.
         c) Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.
         d) Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.
         e) Certified training programs, as offered by ISA.

v) Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.

a) Financial Statement.

b) Balance Sheet.

c) Dun & Bradstreet Report.

vi) This submittal is due no later than two (2) weeks prior to Bid Date. Bidders will be advised of approval or rejection in writing no later than fourteen (14) days prior to Bid Date. Rejected submittals may be supplemented with additional information and resubmitted no later than one (1) week prior to the Bid Date. Bidders making supplementary submittals will be advised of approval or rejection in writing no later than three (3) days prior to Bid Date. Approval of a completed Evidence of Experience by the Engineer is dependent on his determination that the proposed system integrator has sufficient company experience, company expertise, and experienced qualified personnel in new and remodeling work on municipal instrumentation and control systems, has the ability to understand and perform the Work specified, has sufficient financial resources and has not had a detrimental impact to the scope, schedule and budget of work they performed or work performed by others on prior construction projects.

1.06 INTERPRETATION OF DRAWINGS

A. The Drawings are not intended to show exact locations of instrumentation, control panels, or other pieces of equipment. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of the instrumentation and controls work, and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

B. Verify with the Engineer the exact locations and mounting heights of any instrumentation, control panels or other furnished devices that requires regular maintenance or operator access for the safe operation of the process and associated equipment.

C. Any work installed contrary to or without approval by the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

D. Surface mounted instrumentation, control panels, junction boxes, and other devices provided under this division shall be supported by spacers (minimum 1, inch) to provide a clearance between wall and equipment.

E. Floor mounted instrumentation mounting stands, analyzer cabinets, control panels, and other devices provided under this division shall be anchored to and placed on top of housekeeping pads to prevent incidental damage to said equipment during normal operation and housekeeping of the facility.

F. All process, pneumatic, and electrical connections to furnished instrumentation and other controls shall be made as required, and in accordance with the approved shop drawings.

G. Redesign of instrumentation, electrical, or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment, and/or layout other than specified herein, shall be done by the Contractor at his own expense. Redesign and detailed plans

shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his own or others, caused by such redesign.

H. The Contractor shall coordinate his work with the work of the different trades so that interferences between instrumentation, control panels, conduits, piping, equipment, and architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the Contractor without additional expense to the Owner. In case interference develops, the Engineer is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

1.07 PRIORITY OF THE CONTRACT DOCUMENTS

A. If during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and Drawings, furnish the higher performance requirements. The higher performance requirements shall be considered the equipment, material, device or installation method that represents the most stringent option, the highest quality, or the largest quantity.

B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.

C. Detailed Drawings shall govern over General Drawings, larger scale drawings take precedence over smaller scale drawings and Change Order Drawings shall govern over Contract Drawings. Contract Drawings shall govern over Shop Drawings until Shop Drawings have been approved by the Engineer.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provision of the Contract Documents will take precedence if they are more stringent or cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between laws and regulations, the higher performance requirements shall be binding on the Contractor, unless otherwise directed by the Engineer.

E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify and increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times.

1.08 SUBMITTALS

A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for

determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. In accordance with the General Conditions and the Special Conditions of the Contract, submit to the Engineering the following documentation to demonstration compliance with submittal requirements of the Contract:

C. Shop drawings including copies of all drawings, parts lists, product data, and other materials shall be submitted and shall include:

1. Project Execution Plan. The project execution plan shall be submitted and approved before any further submittals will be accepted.
2. Process Instrumentation and Controls Submittal including complete Instrumentation List. For all instruments and control devices, provide a complete Instrument Spec Sheet; vendor product information including Model Number breakdown; Product Data Cut sheets; Instruction Manuals; and sizing calculations where applicable.
3. Process Instrumentation and Controls Specialty Cable list signed off by Contractor and/or Electrical Subcontractor as to required cable lengths.
4. Control Panels including all components and devices per Specification 13200.
5. Control System Project Execution Plan, if Control System Subcontractor is different from Instrumentation and Controls Subcontractor. The Control Systems project execution plan shall be submitted and approved by Engineer and Instrumentation and Controls Subcontractor before any further Control Systems submittals will be accepted.
6. Control System Hardware Submittal including Bill of Materials and Instruction Manuals.
7. Control System Software Submittal including description of software packages, graphic printouts, and operating instructions.
8. Documentation of Foreign Device Interfaces and Implementation of Virtual I/O communication design relative to required interfaces to non-division 13 control systems.
9. Telemetry System Project Execution Plan, if Telemetry System Subcontractor is different from Instrumentation and Controls Subcontractor. The Telemetry Systems project execution plan shall be submitted and approved by Engineer and Instrumentation and Controls Subcontractor before any further Control Systems submittals will be accepted.
10. Telemetry System Hardware and Software Submittal, if applicable.
11. ISA S5 Style Wiring Drawings (Loop Sheets).
12. Control System Interconnection drawings and/or fully annotated mark-ups of standard control system vendor documentation.
13. Telemetry System (if applicable) Interconnection drawings and/or fully annotated mark-ups of standard telemetry system vendor documentation.
14. "Signed Off" Instrumentation and Controls Calibration Reports.
15. "Signed Off" Functional Testing Reports.

16. Training Plans.

17. Spare Parts, Expendables, and Test Equipment.

D. Prior to submittal, all shop drawings shall be checked for accuracy and Contract requirements. Shop drawings shall bear the date checked. Shop drawings shall include any additional deviations from the Contract not noted in the associated project execution plan submittal (see Paragraph 1.08). If deviations from the Contract Specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Each submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections along with justifications for any requested deviations to the specification requirements with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

E. The Engineer's check shall be only for conformance with the design concept of the project and compliance with the Specification and Drawings. The responsibility of, or the necessity of, furnishing materials and workmanship required by the Specifications and Drawings, which may not be indicated on the shop drawings, is included under the work of this Section.

F. The responsibility for all dimensions to be confirmed and correlated at the job site and for coordination of this work with the work of all other trades is also included under the work of this Section.

G. No material shall be ordered or shop work started until the Engineer's approval of shop drawings has been given.

H. After Installation and Testing is complete and approved, submit Record Documents per Paragraph 1.09 "Record Drawings".

I. After Record Drawings have been approved, submit Operation and Maintenance Manuals per Paragraph 1.10 "Operation and Maintenance Manuals".

1.09 PROJECT EXECUTION PLANS

A. Each Project Execution plan shall included the approach to work, proposed control system architecture diagrams, the proposed work schedule including milestones and potential meetings, proposed project personnel and organization, details of factory and field testing, details of training programs, and a paragraph by paragraph review of the specifications indicating any proposed deviations. The schedule shall illustrate all major project milestones including the following:

1. All major project activities including duration.
2. Schedule for all subsequent project submittals.
3. Tentative dates for all project design review meetings.
4. Schedule for manufacturing and staging of all process instrumentation and controls system equipment (or telemetry system equipment as applicable).
5. Schedule for all factory and/or panel shop testing.

6. Schedule for shipment of all process instrumentation and control systems equipment (and/or telemetry system equipment) including all peripheral devices.
7. Schedule for all field testing.
8. Schedule for all training.

B. The Project Execution Plan shall be submitted and approved before any further work or submittals are generated by that Subcontractor. The Subcontractor will continue to update his schedule after approval by the Engineer and provide periodic updates to the Engineer and Owner to allow monitoring of his progress. Notice of difficulties in design or procurement or delivery or installation, decisions to be made, and requests for information shall be performed in a timely manner in writing to the Engineer and Owner. Under no circumstances should failure to notify the Engineer or Owner of these conditions constitute a delay in project schedule or an increase in the project cost or scope.

C. Control System and/or Telemetry System project execution plan shall be reviewed with the Instrumentation and Controls Subcontractor prior to submittal to the Engineer. The Instrumentation and Controls Subcontractor shall be the primary party responsibility to coordinate the design, implementation, and testing with all other parties providing labor, supervision, services, materials, equipment, documentation, and incidentals associated with the "Scope of Work" under this Contract Division. Disagreements, Failure to resolve conflicts, and unresolved issues between all parties shall be noted in each preliminary project execution plan and in each subsequent project schedule update or coordination/review meeting with the Engineer or Owner. Under no circumstances should failure to notify the Engineer or Owner of these conditions constitute a delay in project schedule or an increase in the project cost or scope.

D. Each Project Execution Plan submitted for approval shall include a copy of the applicable contract specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Each Project Execution Plan submitted for approval shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justifications for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire Project Execution Plan with no further consideration.

E. Each Project Execution Plan shall include a personnel staffing plan. This staffing plan shall include the project manager, project engineers and all field technicians/staff that are anticipated to be used on this project. The staffing plan shall include up to date resumes for all personnel identified. Substitution of personnel during the course of the project shall require written approved by the Engineer.

1.10 RECORD DOCUMENTS

A. Prepare and submit record documents indicating installed conditions for:

1. A complete list of the instruments and other equipment supplied, including serial numbers, calibration ranges, and other pertinent data (can be submitted as part of the associated final O&M Manual).
2. Instrument Spec Sheets corrected to reflect the "as-constructed" condition of each instrument or control device.
3. Process Instrumentation and Controls Specialty Cable list with installed cable lengths.
4. A complete "As Constructed" set of approved shop Drawings including the following drawings:
   a. Control Panel general arrangement and wiring drawings plus complete identified parts lists.
   b. ISA S5.4 Style Wiring Drawings (Loop Sheets).
   c. Control System Interconnection drawings and/or fully annotated mark-ups of standard control system vendor documentation.
   d. Telemetry System (if applicable) Interconnection drawings and/or fully annotated mark-ups of standard telemetry system vendor documentation.

B. Subcontractors under this Division shall assist the "installers" of equipment provided under these Division 13 Specifications in providing record documents showing the dimensioned locations of control panels and other enclosures containing instrumentation and controls equipments.

1.11 OPERATION AND MAINTENANCE MANUALS

A. Prepare operation and maintenance manuals include the following information for all process instrumentation and controls provided:

1. O&M Manual Title Page including Project Title, Owners Name and Address, Equipment Name, Equipment Tag Numbers (or reference detail index of materials enclosed), related Contract Specification number, Models Numbers (or reference detailed list of model numbers enclosed), and Purchase Order Number.
2. Comprehensive Table of Contents including Section and Page numbering.
3. Composite List of Manufacturer and Model Number information for all equipment and components furnished. Serial Numbers of each component shall be included when available.
4. Statement of Warranty provided along with vendor and service contact information. Provide name, address, and telephone number of the local supplier.
5. Summary of recommended inspection and maintenance schedule. Provide list of test equipment and tools required and spare parts provided with contract.
6. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
7. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

8. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
9. Connection and Wiring drawings including electrical and instrumentation schematics.
10. Servicing instructions and lubrication charts and schedules.

B. Operation and Maintenance Data

1. Submit complete operations and maintenance data for all equipment furnished under this Division. The manuals shall be prepared specifically for the installation and shall include all required cuts, drawings, equipment lists, descriptions, complete parts list, etc, that are required to instruct operating and maintenance personnel unfamiliar with such equipment.
2. Submitted data should be fully annotated for specific equipment actually being supplied. Optional components and/or instructions should be "crossed out" to facilitate safe operation and to allow for accurate and complete maintenance.
3. In addition to printed documentation provide at least two (2) sets of CDs containing electronic copies of all CAD drawings, spreadsheets, electronic PC, PLC, or DCS programs, and other calculations, programs, or documentation generated used to perform work under this Division.

1.12 CODES, INSPECTIONS AND FEES

A. All equipment, materials, and installation shall be in accordance with the requirements of the local authority having jurisdiction.

B. Contractor shall obtain all necessary permits, inspections, certificates of acceptance, certificates of occupancy, etc. Contractor shall pay all fees related to these items. Contractor shall submit to the Authority Having Jurisdiction the necessary Drawings in the size and quantity as required by the Authority Having Jurisdiction. These permits, inspections, and certificates shall cover all aspects of the process instrumentation and controls. The permits, inspections and certificates shall be obtained by Contractor from the appropriate Authority Having Jurisdiction including, but not limited to, building departments, inspection authorities, plan review examiners, fire marshals, insurers, etc.

C. Obtain required inspection stickers indicating installation suitability from the local authority having jurisdiction. Install as directed by authority having jurisdiction.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Instrumentation, materials, and controls furnished under this division shall meet the following Shipping Requirements:

1. Prior to shipment of all factory and/or panel shop assembled equipment or control panels, The Engineer and/or Owner shall have the option to witness the testing of said equipment in accordance with the Testing Sections of these Specifications. Additionally, the Engineer and/or Owner may wish to inspect the condition and packaging of said equipment prior to its shipment. Provide at least two weeks written notice of all testing and shipments to the Engineer and Owner.
2. After completion of shop assembly, factory test, and approvals; all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty

polyethylene envelopes or secured sheeting to provide complete protection from damage, dust and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at job site.

3. Special instructions for proper field handling, storage and installation required by the manufacturer for proper protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in re-sealable plastic bags or other acceptable means of protection.

4. None of the control equipment shall be shipped to the site until the room(s) are environmentally suitable.

5. All sensitive electronic or computer equipment and control panels/cabinets for the Control System or Telemetry Systems supplied under this Division shall be shipped to the job site via dedicated air ride van.

B. Instrumentation, materials, and controls furnished under this division shall meet the following Identification Requirements:

1. Each component shall be tagged to identify its location, tag (or equipment) number and function in the system. Identification shall be prominently displayed on the outside of the package.

2. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the Drawings, shall be provided on each piece of instrumentation or controls supplied.

3. All instruments, controls, and other equipment delivered to the jobsite shall be properly identified with tag or equipment name, manufacturer, model number and description. Provide inspection stickers, testing certificates, compliance labels, and other information needed as specified and required for each piece of equipment.

C. Instrumentation, materials, and controls furnished under this division shall meet the following Delivery Requirements:

1. Each delivery shall be accompanied by a complete Bill of Lading including a detailed description (type of container, size, and weight) of each package or shipping container included in the shipment. Inspect each item for completeness against Bill of Lading; if it is to be stored, reseal for protection; unpack and handle equipment in accordance with manufacturer's recommendations.

2. Supplier shall provide "signed off" Bill of Lading for each shipment. Bills of Lading shall be provided with monthly status reports required by paragraph 1.09, Project Execution Plans.

3. Receiver of all shipments shall retain records of all shipments and shall keep records of storage locations. Shipments shall be available for inspection by Engineer and/or Owner prior to installation.

4. Receiver of all shipments shall inspect each shipment for delivery condition. Provide timely notification to shipper and Engineer and Owner of any damage discovered during receipt, storage, and installation of all equipment.

D. Instrumentation, materials, and controls furnished under this division shall meet the following Storage Requirements:

1. Control Panels, I/O Cabinets, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters and shall be adequately protected against mechanical injury. If any equipment has been damaged, such damage shall be replaced by the Contractor at his own cost and expense.

2. Equipment and materials stored outdoors shall be covered to keep clean and to protect from dust and dirt. Store on pallets or shelves so that there is no exposure to rain or standing water. Storage environment shall be compatible with the enclosure provided for the instrument or control device and shall prevent exterior or internal damage from rain, dirt, dust or corrosion. Keep equipment clean by covering or by other measures as necessary.

3. If any instrumentation or control component has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged units or systems shall remain on site and returned to the manufacturer after the replacement units or systems have been delivered to the site. Under no circumstances will instrumentation or controls damaged by water be rehabilitated or repaired, new equipment shall be supplied, and all costs associated with replacement shall be borne by the Contractor.

4. Control panels and I/O Cabinets shall be stored on level surfaces to prevent damage or warping.

5. Control Panels and I/O Cabinets shall not be stored out-of-doors even if designed for outdoor installation until temporary or permanent sun and rain shields have been erected at the installation or storage location (assuming the enclosure is rating for outdoor installation).

   Instrumentation and Controls equipment are often extremely sensitive to static electricity and extremes of humidity and temperature. Consult manufacturer guidelines for limits of environmental exposure to provide adequate Heating and Ventilation means where normal storage conditions would violate said manufacturer guidelines or warranties. Should materials or equipment be damaged by improper storage, the Contractor at his own cost and expense shall replace such equipment or materials.

6. Project delay costs associated with improper storage or replacement delays shall be the sole responsibility of the supplier and/or Contractor.

1.14 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passing through such restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to ensure that the tilting does not impair the functional integrity of the equipment.

1.15 Y2K DATE COMPATIBILITY

A. All furnished instrumentation and controls shall utilize time and date keeping functions that are compatible with the use of time and date information for dates beyond December 31, 1999. This time and date functional compatibility is also known as Year 2000 (Y2K) date compatibility. All furnished components shall inheritably provide for (or be upgradeable to provide for) Y2K compatibility unless specifically exempted in writing by the Owner and Engineer.

B. The requirement for time and date functions to be compatible with dates beyond December 31, 1999 shall be implemented with the following minimum provisions:

1. No value for current date will cause any loss of functionality or result in any improper operation.
2. Real time clocks, and time and date calculations shall provide consistent results for dates before; during; and after the start of the Year 2000 Julian calendar year.
3. In all displays and data storage, the "century" associated with any date must be determined either explicitly (i.e. by stored/entered numeric value) or by unambiguous algorithms or by unambiguous interfering rules.
4. Real time clocks or the database entry of time and date information shall utilize date information whereas the associated "year" is entered/stored as a four digit (or larger) numeric value or as a two digit "year" numeric value followed by at least two numeric digits for the "century". Time and date calculations utilizing the amount of time (seconds, etc) from a fixed date (like birth of Unix – 1/1/1970 or birth of IBM compatible PCs (MS-DOS) – 1/1/1980) shall be avoided (i.e. the use of unambiguous algorithms should be avoided). The use of interfering rules to determine the century of the associated year shall be avoided (i.e. the year is stored only as a two digit numeric number with the century determined by whether the year is above or below a certain value – say year at or below 50 meaning the century is "19" or if the year is say 51 then the century is "20").
5. Year 2000 must be recognized as a leap year (Leap Years are defined as those years that are divisible by 4 except for the start of centuries which must also be divisible by 400; i.e. 1900 is not a leap year but 2000 is a leap year).

1.16 PROJECT/SITE REQUIREMENTS

A. Site Elevation. Equipment shall be designed to operate at a ground elevation of approximately 820 feet above mean sea level. Equipment located below grade shall be NEMA Type 4X rated.

B. Temperature. Indoor field equipment shall be suitable for normal operation from 40 to 105 F degrees ambient. Outdoor field equipment shall be suitable for normal operation from -20 to 120 F degrees ambient. Storage temperatures will range from 32 to 140 F degrees ambient. Additional cooling or heating shall be furnished if required by the equipment furnished. Equipment in air-conditioned areas should be suitable for normal operation from 60 to 80 degrees Fahrenheit with short-term excursions to the temperature limits specified for indoor equipment.

C. Relative Humidity. Air-conditioned area equipment shall be suitable for 20 to 80 percent relative, non-condensing humidity. All other equipment shall be suitable for 10 to 100 percent relative, condensing humidity.

D. Availability of AC Power Supplies

1. 120 volts, 60 Hertz, Single Phase AC sources of electrical power will be provided unregulated industrial panel boards.
2. 480 volts, 60 Hz, Single Phase AC sources of electric power will be provided from unregulated 480VAC industrial panel boards, as required.
3. 480 volts, 60 Hz, Three Phase AC sources of electric power will be provided from contactors located in low voltage MCC's or from three phase 480VAC industrial panel boards as noted in the Division 16 Drawings.

E. Availability of compressed air or High Quality Instrument air:

1. Standard quality compressed air is unavailable unless a new plant air compressor is provided under the Division 11 specifications.
2. High Quality Instrument air is unavailable unless provided by others.

1.17 WARRANTY

A. Provide a warranty for all instrumentation and controls in accordance with the general requirements of the Contract Specifications. Unless specified more stringently elsewhere in the general requirements, the components of the instrumentation and controls system shall be warranted against defective materials, design, and workmanship for a period of one (1) year from the date of final acceptance.

B. During the warranty period, Subcontractor shall furnish personnel to inspect, test, and take corrective action to correct all deficiencies in his "Scope of Work" such that the corrective action is consistent with the quality of materials and work of the original construction and is in conformance with the Contract Specifications, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials of the same type shall be the product of one (1) manufacturer.

B. The materials used shall be new, unused and as hereinafter specified. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturers product specifications shall be submitted for approval as required by the Engineer.

C. All current carrying cables, wires, buses, terminals, windings, parts, etc. shall be copper. Exception shall be made to this section is for circuits involving thermocouple circuits where the wiring, terminals and/or other current carrying parts shall be made from the same materials as that of the thermocouple.

D. Materials and equipment furnished shall be suitable in all ways for the intended application. Ratings shall match or exceed the requirements of the indicated Reference Standards, Drawings and Specifications.

2.02 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, instrumentation and control system enclosures shall have the following ratings.

1. NEMA 1 for dry, non-process indoor locations.
2. NEMA 12 for "DUST" locations.
3. NEMA 4X for outdoor locations, rooms below grade (including basements and buried vaults), "DAMP" and "WET" locations. Enclosure material shall be carbon steel with baked or electrostatically applied enamel finish, or stainless steel.
4. NEMA 4X for "CORROSIVE" locations. Enclosure material shall be stainless steel or fiberglass reinforced polyester (FRP). All FRP panels located in direct sunlight shall be provided with a protective coating to prevent discoloration and cracking.
5. NEMA 7 (and listed for use in the area classifications shown) for "Class I, Division 1"; "Class I, Division 2" and "Hazardous Locations". Enclosure material shall be cast malleable iron.
6. Refer to Division 16 Drawings for hazardous area classifications.
7. Installations in Outdoor areas require sun shields.

2.03 REQUIREMENTS FOR HAZARDOUS AREAS

A. All equipment, materials, and installation techniques used in areas designated as hazardous in the Specification Sections, or on the Contract Drawings shall be in strict accordance with National Electrical Code Articles 500, 501, 502, 503, and 504.

B. Unless auxiliary protective means as noted below are utilized, all equipment and materials that are supplied shall be labeled and approved for safe operation and inheritable designed for used in hazardous areas. Such equipment and materials shall be UL listed for the appropriate hazardous area classification.

C. Unless otherwise noted on the Contract Drawings, the Engineer intends that instrumentation and controls located in Electrically "Hazardous Locations" be inherently suitable (i.e. use of explosion proof NEMA 7 or NEMA 9 enclosures) to meet the electrical area classifications. Should the Contractor or Subcontractors provide instrumentation, auxiliary devices, or other control equipment that is not inherently suitable for intended environment; the design, implementation, or use of Intrinsic Safety barriers or other mechanical or electrical means of guaranteeing the suitability of the said instrumentation, auxiliary devices or other control equipment to safely operating in its intended environment shall only be implemented at the expense of the installer or supplier of said equipment. The supplier has the responsibility to coordinate with all other Contractors and Subcontractors affected to notify them of the impact and negotiate the sharing of the costs and other impact associated with the use of alternate designs.

D. The common engineering practice of the use of float level switches for monitoring the levels in sumps and other areas, which are often considered electrical hazardous, is an example of the implied intent of the Engineer in his design documents that the Contractor and/or his suppliers and/or subcontractors can be reasonably expected and required to provide additional materials and methods to make use of the specified device in what may well be a electrically "hazardous location". The Contractor and/or his suppliers and/or subcontractors may choose to use a more

expensive device (that is inherently suitable for the intended location) in implementing the engineering design if he or she so chooses but at no time shall there be any additional cost or schedule impact to the Owner.

E. The use of Intrinsic Safety (IS) as an auxiliary protection means shall be designed, installed, and testing in compliance with the National Electrical Code Articles 500, 501, 502, 503, and 504. Additionally, the Intrinsic Safety design, installation, and testing shall comply with the following:

1. Devices utilized in Intrinsically Safe (IS) applications must be certified and stamped as being suitable for use in the intended area classification. Certifications of all IS devices shall be submitted along with the associated instrumentation and controls. Failure to submit proper certifications and/or IS Design calculations shall not constitute approval of the auxiliary protection means by the Engineer.
2. Zener Diode style IS Barriers must be grounded in compliance with National Electrical Code Article 504 and ANSI/ISA Recommended Practice 12.06.01. Provide at least AWG # 6 insulated Green Wire to a dedicated ground rod or grounding triad as necessary to get less than 1 ohm to ground resistance. Dedicated IS grounding system shall (and must) only be connected at one point to the plant ground grid (if grounding triad used, Connection to IS Barriers at one leg of triad and connection to plant ground grid from another leg of the triad should be used to guarantee a good and high quality path to earth ground).
3. Simple Apparatus (Switches, etc.) can be provided with Switch Amplifier type IS Barriers that do not require a dedicated IS Grounding connection to the IS Barrier.
4. Energy storing devices (i.e. transmitters, etc) have Entity parameters that must be utilized in developing the IS Barrier design to ensure that installation will be suitable for the intended electrically "hazardous location". Vendor furnished Entity parameters and IS Barrier design calculations shall be submitted for approval in these applications.
5. IS Barriers should be located in an electrically non-hazardous area such that the incoming hazardous ISS wiring from field devices is electrical isolated at the IS barrier from the regular non-hazardous wiring leaving the IS Barrier.
6. IS wiring inside control panels shall be separated by 2 inches of air space from all regular non-hazardous wiring. All IS wiring inside enclosures shall be secured so that any conductor that might come loose from a terminal cannot come in contact with another terminal. Grounded Metal or Isolated Partitions are permitted by NEC Code Article 504-30 with lesser distance requirements.
7. Wiring ducts in Control Panels containing IS circuits shall be colored light blue or identified with labels containing the wording "Intrinsic Safe Wiring" or the equivalent.
8. IS wiring shall be located in dedicated conduits separated from any non-hazardous wiring.
9. Conduits where above ground containing IS wiring shall be identified with labels containing the wording "Intrinsic Safe Wiring" or the equivalent per NEC Article 504-80.b. Spacing between labels shall be no less than every 25 feet.
10. IS wiring shall be color coded light blue where no other conductors colored light blue are used per NEC Article 504-80.c.
11. Conduits containing IS wiring where entering enclosures containing regular non-IS wiring shall be sealed to prevent possible transmission of gases from hazardous areas.

2.04 INSTRUMENTATION – GENERAL REQUIREMENTS

A. To facilitate the Owner's future operation and maintenance, all furnished products shall be of the same major instrumentation manufacturer, with control panel mounted devices of the same type and model as far as possible. For existing facilities, every effort shall be made to supply equipment of the same major manufacturer and model as those predominately found at the Owners facility unless written approval is obtained from the Owner and/or Engineer.

B. All instrumentation supplied shall be of the manufacturer's latest design and shall produce or be activated by signals, which are established standards for the water and wastewater industries.

C. All pneumatic instrumentation shall be furnished with coalescing filters and/or filter regulators and shall utilize high quality instrument air to generate linear transmission signals of 3 to 15 PSIG.

D. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mA DC (milliampere direct current), however, signals between instruments within the same panel or cabinet may be 1-5V DC (volts direct current), or the like.

E. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed.

F. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks as shown on the Drawings or as required.

G. Equipment installed in a hazardous area shall meet Class, Group, and Division as shown on the Electrical Drawings, to comply with the National Electrical Code.

H. All indicators and recorder read-outs shall be linear in process units, unless otherwise noted.

I. All transmitters shall be provided with either integral indicators or junction box mounted indicators that display all measurements in process units, accurate to two percent.

J. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture and fungus. Solid state components shall be conservatively rated for their purpose, to assure optimum long term performance and dependability over ambient atmosphere fluctuations and 0 to 100 percent relative humidity. The field mounted equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

K. All equipment, cabinets and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, in-so-far as possible, and shall consist of equipment models which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

L. The field mounted digital system equipment and system components shall be designed for installation in dusty, humid, and slightly corrosive service conditions.

M. All electronic/digital equipment shall be provided with radio frequency interference protection and shall be FCC approved. Instrumentation should be able to operate normally (causing no more

than 0.75% change in accuracy) when exposed to Electromagnetic Radiation of approximately 10 Volts/meter at frequencies from 27 to 500 Mhz.

N. All electrically operated equipment shall be designed to operate on an alternating current power source [Voltage and Frequency as noted in Site Conditions, Paragraph 1.20], plus or minus 10 percent, except where specifically noted. All regulators and power supplied required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

O. All electrical operated equipment furnished shall be U.L. approved wherever such approved equipment is available.

P. All electrically operated equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

2.05 TRANSIENT SURGE AND LIGHTNING PROTECTION

A. General Requirements – Transient Surge and Lightning and protection shall be provided to protect all instrumentation and controls from induced voltages and power surges propagating along the analog or discrete signal and/or power supply lines or digital communication connection to the Control system and/or Telemetry system. The protection systems shall be such that the surge protective device shall not interfere with normal operation, but shall lower the induced voltage level or transient surge level to be less than the instrument's (or control device's) surge withstanding level, and shall be maintenance free and self-restoring, if possible. All connection points to be copper with nickel plating. The surge protective device should meet IEEE C-62-41 Standards.

B. Additional Requirements shall be as required in Division 13 Contract Specification 13270 – Surge and Lightning Protection.

C. The supplier of instrumentation and controls associated with this Division shall provide the appropriate surge protective device as required by this Division. Instrumentation and Controls Subcontractor shall provide any additional surge protective devices, materials, supervision, installation, and testing if the supplier of any instrumentation and controls under the Contract Specifications does not satisfy the intent of the Division 13 Contract Specification 13270 – Surge and Lightning Protection.

2.06 INSTRUMENTATION TUBING AND FITTINGS

A. All instrument air header takeoffs and branch connections less than 2-in shall be 316 stainless steel or copper as noted in the mechanical (piping) specifications.

B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the Mechanical (piping) specifications and all instrument installation details. Instrument fittings and valves shall be match the predominant standard at the existing facility unless other specified in the mechanical (piping) specifications.

C. Unless otherwise specified in the mechanical (piping) specifications, all instrument tubing shall be fully annealed ASTM A269 Seamless 316 grade free of O.D. scratches having the following dimensional characteristics as required to fit the specific installation:

1. 1/4-in to 1/2-in O.D. x 0.035 wall thickness.
2. 5/8-in to 1-in O.D. x 0.049 wall thickness.
3. 1-in O.D. x 0.065 wall thickness.
4. 1-1/4-in O.D. x 0.065 wall thickness.
5. 1-1/2-in O.D. x 0.083 wall thickness.
6. 2-in O.D. x 0.095 wall thickness.

D. All process connections to instruments shall be annealed 1/2-in O.D. stainless steel tubing, Type 316.

E. All tube track shall be supported by stainless steel and installed as per manufacturer's installation instructions.

2.07 MAINTENANCE REQUIREMENTS

A. Spare Parts

1. Spare parts shall be as defined in the related specification sections. All spare parts shall be new and unused.
2. All spare parts shall be individually packaged and labeled.
3. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.
4. Provide one gallon of touch-up paint, in one-quart containers, for each type and color used for all cabinets, panels, consoles, etc., supplied under the related specification sections.
5. The spares listed above shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperature.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of instrumentation and controls work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

B. The P&IDs and Contract Drawings indicate the intent of the interconnection between the individual instruments. Any exceptions should be noted. Two complete sets of approved shop drawings shall be kept at the job site during all on-site construction. Both sets shall be identically

marked up to reflect any modifications made during field installation or start-up. All markings shall be verified and initialed by the Engineer or his designated representative.

C. Following completion of installation and the operational readiness testing, one set of the marked up drawings shall be provided to the Engineer, the other retained by the Supplier for incorporation of the mark-ups into final as-built documentation.

D. Instrumentation and Controls furnished under this Division shall be factory and/or "bench" calibrated prior to installation and testing.

E. The instrumentation installation details on the Contract Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the American Petroleum Institute (API) Recommended Practice 550 shall be followed as applicable.

F. All work shall be executed in full accordance with codes and local rulings. Should any work be performed contrary to said rulings, ordinances and regulations, the Contractor shall bear full responsibility for such violations and assume all costs arising there from.

G. All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Supplier shall bear full responsibility for such violations and assume all costs arising there from.

H. Unless specifically shown in the Contract Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or pipe stands. All instrumentation process and instrument air connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing, and blow down service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

I. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors, and shut-off valves.

J. Field instruments requiring AC power supply shall be provided with local electrical shutoffs, and fuses as required.

K. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed in a workmanlike manner and not interfere with any other equipment.

L. The Instrumentation and Controls Subcontractors hall investigate each space in the building through which equipment must pass to reach its final location. If necessary, the Instrumentation and Controls Subcontractor shall be required to ship his material in sections sized to permit passing through restricted areas in the building. The ISS shall also investigate, and make any field modifications to the allocated space for each cabinet, enclosure and panel to assure proper space and access (front, rear, side).

M. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

N. Lifting rings from cabinets/assemblies shall be removed. Hole plugs shall be provided for the holes of the same color as the cabinet.

O. The Instrumentation and Controls Subcontractor, acting through the Contractor, shall coordinate the installation, the placing and location of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval. He shall be responsible to ensure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to ensure a satisfactory functioning installation. The Instrumentation and Controls Subcontractor hereunder shall schedule and coordinate his work under this section with that of the electrical work specified under applicable Sections of Division 16.

P. Installation of Fiber Optic Cable. Refer to cable manufacturer's specifications for bend radius. Use cable breakout assembly as recommended by the cable manufacturer. Provide wire basket, strain relief as required to meet manufacturer's strain requirements.

Q. Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged units or systems shall remain on site and returned to the manufacturer after the replacement units or systems have been delivered to the site. Under no circumstances will instrumentation or controls equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied, and all costs associated with replacement shall be borne by the Contractor.

R. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer. The entire damaged enclosure panel or section shall be repainted per manufacturers recommendations to restore the original finish, at no additional cost to the Owner.

3.02 INSPECTION AND TESTING

A. Test all instrumentation and control system components furnished under this Division and repair or replace all defective equipment or work. Comprehensive testing and demonstration of proper operation of all equipment shall be required as part of this Contract. Operation and testing shall be demonstrated to the Owner's satisfaction as a requirement for final acceptance of the equipment being supplied. All inspection and testing furnishing for the project shall also conform to the Contract Requirements including those included in the General Conditions Specification 01650 "Facility Startup". The Subcontractor shall schedule and coordinate all inspections and testing with General Contractor and any other applicable subcontractors. The General Contractor shall notify the Engineer and Owner at least two weeks prior to all factory and field tests. The Engineer and/or Owner shall have the option to inspect all tests at the factory and in the field.

B. Contractor to submit written Test Procedures at least 30 days prior to the start of the contractual required shop tests, field performance tests, and final acceptance tests as specified in the Contract Specifications and Drawings.

C. Pre-Operational Testing: Perform the following minimum tests and checks prior to attempting to test the Instrumentation and Controls for plant operation on a system-by-system basis.

1. Inspection and Calibration: Perform pre-operational visual and mechanical inspection, calibration (calibration of new/existing instrumentation or verification of vendor pre-calibrated instruments), and verification of proper operation for all instrumentation and controls provided under this Division. For analog instruments, instrument calibration check shall list at least five points where the calibration was verified (0, 25%, 50%, 75% and 100% of span). For discrete instruments, verify switch operation at set point and note the reset setting. Submit an individual calibration sheet for each piece of instrumentation and controls. Calibration sheet shall be legibly signed off by person(s) performing this test and shall list all conditions found and all corrective actions taken. Complete step-by-step filled-in calibration settings sheets shall be provided for each transmitter that requires application specific settings beyond simple zero and span settings. These calibration settings sheets shall be complete enough to allow the maintenance personnel to restore the "as-constructed" settings to an instrument that has to be replaced in the future.

2. Factory Power and Grounding Tests: Test grounding and verify any other safe operation concerns associated with all supplied control panels, PLC hardware, intrinsic safety equipment, and other sensitive electrical or electronic control system equipment prior to energization. Supplier shall certify that the grounding and installation is in conformance with the manufacturer's warranty requirements prior to providing temporary or permanent power to any supplied equipment.

3. Electronic Burn-in Testing: All electronic or solid-state components include Personal computers, PC peripherals, Computer Network equipment, and PLC/DCS/Telemetry System Hardware shall be operated continuous without failure for at least 48 hours prior to factory or field operational testing (and preferably before field installation). Instrumentation and Controls inside control panels and I/O Cabinets shall be tested before shipment to jobsite. Submit for approval copies of certified test reports including actual test data, observations and certification that the electronic burn-in tests have been completed.

4. Unwitnessed Factory Testing: All vendor furnished fabricated control panels or factory assembled systems shall be completely interconnected and tested for full operation and functionality prior to be ready to be shipped for field installation and testing. The vendor and/or fabricator shall perform a complete unwitness factory test on all equipment prior to informing the Engineer and/or Owner that it is ready to ship and offering for either to come to the factory for a full or partial witnessed factory test to confirm the unwitness testing already conducted.actory Panel Testing: All Control System and/or Telemetry System I/O shall be 100% "real world" simulated from I/O card to/from the panel mounted devices or external terminal blocks. In this regard, all control panels and I/O Cabinets shall have a 100 % point to point wiring checkout prior to being shipped from vendor or panel fabricator. Engineer and/or Owner shall have to opportunity to witness all testing. Repair and correct before shipping any deficiencies discovered in the work during the factory panel testing. Submit for approval copies of certified test reports including actual test data, observations, corrective actions taken, and certification that the factory panel tests have been completed and all corrections have been implemented.

5. Field Power and Grounding Tests: Test grounding and verify any other safe operation concerns associated with all supplied control panels, PLC hardware, intrinsic safety equipment, and other sensitive electrical or electronic control system equipment prior to energization. Supplier shall certify that the grounding and installation is in conformance with the manufacturer's warranty requirements prior to providing temporary or permanent

power to any supplied equipment. Submit copies of certified installation and grounding test reports.

6. Field Installation Inspection and Supervision: Unless otherwise noted, Instrumentation and Controls provided under this division shall remain the responsibility of the supplier till turned over to the Engineer and/or Owner (or his assigned Operations Company) for normal plant operation. Instrumentation and Controls shall be inspected for shipping or construction damage and for proper installation before being tested or placed into service. The Control System or Telemetry Subcontractor whom supplied the associated instrumentation and controls shall inspect, calibrate, adjust settings, and ready for operation each component supplied. Subcontractor shall certify that each component is installed per the manufacturer requirements and applicable industry standards and therefore is ready for testing and operation. Repair or replace all defective equipment or work. The supplier shall coordinate with the General Contractor and/or other affected subcontractors to resolve any deficiencies, improper installation, or improper component operation discovered. Repairs to malfunctioning components shall require approval by the Engineer. All costs associated with installation, inspection, testing, calibration, adjustments, repairs, or replacement including expedited shipping charges to meet project deadlines shall be born by the General Contractor or his subcontractors.

7. Field Wiring and Interlock Checkout: Prior to plant operation, inspect and test all instrumentation, controls, and interlocks to verify that the instrumentation and control systems will function properly and as indicated by the Contract Drawings and as noted in the approved shop drawings. The Instrumentation and Controls Supplier shall perform the following checks to certify that the instrumentation and controls are ready for pre-operational testing:
   a. Verify field wiring installation against approved loop sheets and interconnect wiring drawings.
   b. Simulate each instrumentation signal to and from each control panel or field device. Verify that all signals are sent, processed, or received properly. Check controller operation including controller action (direct or reverse) and valve position. Check display ranges against calibration sheets.
   c. Verify that Control System has configured and connected per the approved shop drawings. Verify proper operation of alternate power sources and fault-tolerant hardware (Processors, Network connections, I/O cards – where applicable, etc.).
   d. Verify that all Processors and Operator Consoles have been loaded with the latest software configuration. Verify software I/O addressing and configuration against approved detailed software engineering documents.
   e. Simulate each I/O point to verify that all signals are sent, processed or received properly. Verify the I/O address, display range, and graphic displays associated with each signals.

8. Submit for approval copies of all pre-operational certified test reports including actual test data, observations and certification that each individual test has been completed.

9. Provide all instruments, personnel and equipment required for the tests specified in this Division.

D. Operational Testing: Once all instrumentation and controls have been testing per the Pre-Operational Testing requirements listed above, the Instrumentation and Controls shall be tested along with the associated Mechanical and Electrical equipment provided on this Contract in a

systematic - system-by-system basis. Perform the following minimum tests and checks prior to turning over the Contract supplied equipment for the owner's use:

1. At least 30 days prior to start of Operational Testing, the Contractor shall submit written composite operational testing plan include schedule and procedures. Contractor shall seek input from and approval by with Engineer and/or Owner on his Operational Testing plan before any testing shall commence.
2. Certify that the mechanical equipment (Divisions 11 and 13 equipment including required HVAC equipment provided under Division 15) have been inspected, operated, tested, and adjusted of proper operation by the manufacturer's field technicians in accordance with the Contractual Requirements prior to startup.
3. Certify that associated piping, valves, and other equipment supplied under Division 15 have been inspected, operated, tested, and adjusted of proper operation by the manufacturer's field technicians in accordance with the Contractual Requirements prior to startup.
4. Certify that associated Electrical equipment supplied under Division 16 has been inspected, operated, tested, and adjusted of proper operation by the manufacturer's field technicians in accordance with the Contractual Requirements prior to startup.
5. Certify that associated Instrumentation and Controls supplied under Division 13 has been inspected, operated, tested, and adjusted of proper operation by the manufacturer's field technicians in accordance with the Contractual Requirements prior to startup.

E. Demonstrate that all Control System and Telemetry System Hardware and Software have be installed and configured per Contractual Requirements, including resumption of operation after full Utility Power Failure, verification of failure modes of controls during loss of all power sources or switchover to and from primary power to backup power sources, and verification of continued operation in the event of loss of redundant network or I/O communication links. Virtual I/O communication links shall be tested and verified for fully functionality per approved PLC or DCS Software Submittals.

1. Perform complete operational testing for every piece of equipment, every instrument, and all controls provided under the Contract. All modes of equipment operation shall be demonstrated and all interlocks shall be tested under as realistic process conditions as possible (note where simulation of signals was required).
2. Each test shall be witnessed by the Engineer and/or Owner and shall require signoff by the General Contractor, Person performing the test, and by the Engineer and/or Owner that the Contractual testing requirements have been satisfied. Written testing sign-off forms shall be broken down by each piece of equipment or instrument loop being tested.
3. Two copies of "As-Constructed" approved shop drawings including O&M Manuals shall be available during the testing and all discrepancies and corrections shall be noted completely and legibly on both sets. After testing has been successfully completed – one set of drawings shall be made available to the owner for his use in operating and maintaining the facility. The other set shall be used by the Contractor to generate record drawings.

F. Operational Testing: After individual system operational testing, all equipment performance shall be demonstrated in continuous operation for at least a five (5) day (24 hours a day) period of time as specified required in the General Conditions and Section 01650 - Facility Startup before final acceptance testing can be initiated. The Contractor shall provide for on-site operation and maintenance during this operational demonstration test. If any component of the Control Systems

fails to continuously perform, the performance demonstration testing period must be repeated. The Owner and/or Engineer reserves the right to inspect any rejected component prior to replacement or repair. If corrective measures are to be taken, such measures shall be done on-site at such times as convenient to the Owner and within 90 days of the unsuccessful test. The Owner shall be allowed to use the Instrumentation and Control System supplied immediately following installation and testing whether or not the complete system meets the testing conditions specified.

G. Continuous Field Acceptance Testing: Once all the equipment furnished has been tested to demonstrate Operational performance (Operational Testing requirement) of each component, Contractor shall demonstrate continuous full time operation of all equipment furnished together as a complete and fully functional system. As required under the General Conditions and Section 01650 - Facility Startup, this continous field acceptance testing shall be demonstrated for up to six (6) months of twenty four hours a day operation without interruption or failure except as allowed in the General Conditons.

G. All inspection and testing shall be performed by personnel who are competent and experienced in the use of instrumentation and controls for industrial process control. Personnel shall have complete knowledge in the proper installation, operation, and maintenance of the instrumentation and controls being provided.

H. Manufacturer Representatives: Whereas, the supplier does not have the personnel that are sufficiently experienced and trained to perform all inspections, testing, and training required by the Contract Specifications, the supplier shall provide manufacturer certified representatives to assist his field personnel in performing these requirements at no additional cost to the Owner. The use of manufacturer representatives shall be clearly noted in the approval submittals.

I. All testing shall be scheduled and coordinated by the General Contractor. The Contractor or Subcontractors under this Division shall have qualified personnel present during all testing.

J. All test data and procedures followed during testing shall be logged, and certified copies of the logs shall be provided to the Engineer and Owner.

K. Acceptance of shop tests by Owner or Engineer shall not constitute a waiver of requirements to meet the field tests under specified operating conditions, nor does inspection relieve the manufacturer or supplier of his responsibility in any way.

3.03 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

3.04 TRAINING

A. The Instrumentation and Controls Subcontractor and/or Control System Subcontractor and/or Telemetry System Subcontractor shall be responsible to fully familiarize and train all Technicians, Operators, Engineers, and Managers associated with the Owner's facility on the maintenance, troubleshooting, and operation of the equipment being supplied. Training shall familiarize the Owner with the all equipment furnished including location and application of each type of instrumentation and controls. Additionally, training shall cover all aspects of the calibration, programming, maintenance, troubleshooting, and operation of the Instrumentation

and Controls System. All training for the project shall also conform to the Contract Requirements including those included in the General Conditions Specification 01664 "Training". All costs involving in fulfilling the training requirements including the preparation of training plans and course materials, duplication of training materials, use of audio/visual presentation equipment, post-training individualized testing, and the use of rental equipment to facilitate individualized training shall be included in the contract price.

B. Contractor provided Operations and Maintenance manuals shall be the basis of all provided training. Supplemental information utilized in the course of the training provided shall be turned over to the Owner for his use in performing refresher training or training of new personnel at a later date.

C. Training shall be conducted by professional, full time instructors familiar with the specifics of the Instrumentation and Control System furnished. Training shall be customized to reflect the specific instrumentation and controls furnished and shall additionally be customized to reflect the understanding of the Owner's personnel. Training shall utilize samples of actual applications, teaching aids, excerpts of the O&M Manuals, slide/video presentations, etc. to facilitate learning and retention of the training provided. Training time shall be divided between classroom and "hands-on" instruction. After the training has been successfully completed, all training materials shall be delivered to Owner for his use.

D. Training shall be performed at the Owner's facility utilizing the actual equipment furnished under the Contract. Contractor can supply (at no cost to the Owner) additional similar equipment to facilitate individualized training or to allow training during the simultaneous operation and testing of Instrumentation and Control system.

E. Initial training may be performed before all construction activities are complete. Final operation and maintenance training shall only be performed after all equipment is fully operational and tested.

F. Instrumentation and Control System Training shall be furnished as follows:

1. Overview and Familiarization of the Instrumentation and Controls System
   a. Length of Class: at least 2 hours
   b. Who shall attend: All Technicians, Operators, Engineers, and Managers
   c. Location: Owner's Plant site
   d. Purpose: To provide a general overview of the Instrumentation and Controls being provided and to familiarize the Owner with the types of equipment being provided. This course can be held before all construction activities have been completed.
2. Control System (and/or Telemetry System) Maintenance Training
   a. Length of Class: at least 4 hours
   b. Who shall attend: Maintenance technicians and supervisors
   c. Location: Owner's Plant Site
   d. Purpose: To make the maintenance personnel familiar with the maintenance requirements of the Instrumentation and Control System. Teach the maintenance personnel how to troubleshoot problems with the equipment provided.

3. Control System (and/or Telemetry System) Configuration and Programming Training
   a. Length of Class: at least 4 hours
   b. Who shall attend: Engineering staff
   c. Location: Owner's Plant Site
   d. Purpose: To make the Owner's engineering staff familiar with the specific software applications provided for the Control Systems (and/or Telemetry System). The supplier shall review the Software Documentation provided so that the Owner's engineering staff is familiar with the Control System Architecture and I/O configuration. The supplier shall assume some basic familiarity with the software provided but shall demonstrate how to add and delete I/O points, modify control logic (both analog and discrete), and modify operator graphics and trends.
4. Use and Operation of the Installed Control System
   a. Length of Class: at least 4 hours
   b. Who shall attend: All Technicians, Operators, Engineers, and Managers
   c. Location: Owner's Plant Site
   d. Purpose: To demonstrate the use and functionality of the Instrumentation and Control System provided. Review the operational functions that must be performed at local or vendor furnished control panels. Familiarize the owner with the basic operation of any graphical based Operator Workstations. Provide a complete review of all graphic and trend displays provided.

G. All training schedules shall be coordinated with and at the convenience of the Owner. Training shall be scheduled with the Owner at least two weeks prior to the actual training date. Training may have to be repeated several times to accommodate the owner's work schedule and personnel availability. Training Class size shall to limited to no more than fifteen (15) individuals for each session.

I. Training lesson plans and certifications for all trainers shall be submitted for approval prior to any performed training sessions. Submittal of Training lesson plans and trainer certificates shall be at least three (3) weeks prior to scheduled training. Copies of training lesson plans, training manuals and handout, visual aids, and reference material shall be provided to the Owner at least one week prior to the start of each training session.

H. The Owner reserves the right to videotape all training sessions. All such tapes shall become the sole property of the Owner.

REFERENCE FORMS

The forms listed below and included in this section are referenced from other sections of the specifications:

Form No.	Title
13000-A	Loop Wiring and Insulation Resistance Test Data Form
13000-B	Control Circuit Piping Leak Test Form
13000-C	Controller Calibration Test Data Form
13000-D	Panel Indicator Calibration Test Data Form
13000-E	Recorder Calibration Test Data Form
13000-F	Signal Trip Calibration Test Data Form
13000-G	Field Switch Calibration Test Data Form
13000-H	Transmitter Calibration Test Data Form
13000-I	Miscellaneous Instrument Calibration Test Data Form
13000-J	Individual Loop Test Data Form
13000-K	Loop Commissioning Test Data Form

13000-A. LOOP WIRING AND INSULATION RESISTANCE TEST DATA FORM:

Loop No.:_____

List all wiring associated with a loop in table below. Make applicable measurements as indicated after disconnecting wiring.

			Continuity Resistance [a]		Insulation Resistance [b]			
Wire No.	Panel Tie	Field TB	Cond./ Cond.	Cond./ Shield	Shield/ Gnd.	Shield/ Cond.	Cond./ Gnd.	Shield/ Shield
A			--	(A/SH)				
B			(A/B)	--				
C			(A/C)	--				
D			(A/D)	--				
etc.								

a. Continuity Test. Connect ohmmeter leads between wires A and B and jumper opposite ends together. Record resistance in table. Repeat procedure between A and C, A and D, etc. Any deviation of ±2 ohms between any reading and the average of a particular run indicates a poor conductor, and corrective action shall be taken before continuing with the loop test.

b. Insulation Test. Connect one end of a 500 volt megger to the panel ground bus and the other sequentially to each completely disconnected wire and shield. Test the insulation resistance and record each reading.

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-B. CONTROL CIRCUIT PIPING LEAK TEST FORM:

Loop No.:_____

List tubing associated with loop in table below. Make applicable measurements after isolating any air consuming pilots from circuit.

Tube No.	Tubing Equivalent Length of 1/4-Inch Copper[a]	Test Period (seconds)	Permitted Pressure Drop (psi)[b]	Measured Pressure Drop (psi)
A				
B				
C				
D				
etc.				

a. Convert actual tubing and air motor volume to equivalent 1/4-inch copper tubing.

b. Pressure drop shall not exceed 1 psi per hundred feet 1/4-inch tubing per 5 seconds.

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-C. CONTROLLER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____ Process Variable (PV) Scale: _____

Output: _____ Output Scale: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				

% Deviation Allowed: _____

Connect output to PV for following tests:

	Set Point (SP) Indicator Accuracy			Output Meter Accuracy		Controller Accuracy		
SP	PV Reading	Expected % Dev.	Actual Reading	Expected Reading	% Dev.	Actual Output	Output	% Dev.
(0%)		0%						
(50%)		50%						
(100%)		100%						

% Dev. Allowed:_____ % Dev. Allowed:_____ % Dev. Allowed:_____

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-D. PANEL INDICATOR CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input:

Scale: _____ Range: _____

PV Scale Calibration

% of Range	Input	Expected Reading	Actual Reading	% Deviation
0				
50				
100				

% Deviation Allowed: _____

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-E. RECORDER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____ Chart: _____

Scale: _____ Range: _____

% of Range	Input	Expected Scale Reading	Actual Scale Reading	% Deviation
0				
50				
100				

% Deviation Allowed: _____

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

13000-F. SIGNAL TRIP CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input:

Scale: _____ Range: _____

Set Point(s): _____

After setting set point(s), run signal input through entire range and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-G. FIELD SWITCH CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____

Range: _____

Set Point(s): _____

Simulate process variable (flow, pressure, temperature, etc.) and set desired set point(s). Run through entire range of switch and calculate deadband.

Set Point	Incr. Input Trip Point	Decr. Input Trip Point	Calc. Deadband	Required Deadband

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-H. TRANSMITTER CALIBRATION TEST DATA FORM:

Tag No. and Description: _____

Make and Model No.: _____ Serial No.: _____

Input: _____

Output: _____

Range: _____ Scale: _____

Simulate process variable (flow, pressure, temperature, etc.) and measure output with appropriate meter.

% of Range	Input	Expected Output	Actual Output	% Deviation
0				
50				
100				

% Deviation Allowed: _____

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-I. MISCELLANEOUS INSTRUMENT CALIBRATION TEST DATA FORM:

(For instruments not covered by any of the preceding test forms, the Contractor shall create a form containing all necessary information and calibration procedures.)

CERTIFIED_____ Date_____
Contractor's Representative

WITNESSED_____ Date_____
City's Representative

13000-J. INDIVIDUAL LOOP TEST DATA FORM:

Loop No.:

Description: (Give complete description of loop's function using) tag numbers where appropriate.)

P&ID No.: (Attach copy of P&ID.)

a. Wiring tested:
(Attach test form 13000-A)

b. Instrumentation tubing/piping tested:
(Attach test form 13000-B)

c. Instruments calibrated:
(Attach test forms 13000-C through I)

d. List step-by-step procedures for testing loop parameters. Test loop with instruments, including transmitters and control valves, connected and functioning. If it is not possible to produce a real process variable, then a simulated signal may be used with the Engineer's approval.

CERTIFIED _____ Date_____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

13000-K. LOOP COMMISSIONING TEST DATA FORM:

Loop No.: _____

a. Loop tested:
(Attach test form 13000-J)

b. Controlled or connected equipment tests confirmed:

c. Give complete description of loop's interface with process.

d. With associated equipment and process in operation, provide annotated chart trace of loop response to changes in set points for verification of performance. This chart should demonstrate 1/4-amplitude damping as output adjusts to set point change. Show set points, starting and finishing times on chart, as well as any other pertinent data.

Connect 2-pen recorder to process variable (PV) and to controller output. Use 1 inch/second chart speed.

Pen 1 - PV - Connections:

Pen 2 - Output - Connections:

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

END OF SECTION 13000

Liddell Drive Equalization Facility - Instrument list - Non-Vendor Furnished

I&C Specification: 13100

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Desig Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	As Description	Manufacturer	Model No.	Connection Type	Connection Size	Calibration Low Range	Calibration High Range	Calibration Units	Calibration Notes	Supplier	Device Type	Spec Reference	Physical Location	Power Supply	Notes
	FE	110	A	FE110A	I-101	South Fork Flow Metering Manhole Flow	FloDar Surface Radar Flow Sensor FloDar Surface			L-Bracket off Wall							Field	13300	Flow Metering Structure	N	Marsh McBirney FloDar
	FIT	110	A	FIT110A	I-101	South Fork Flow Metering Manhole Flow	Radar Flow Transmitter			N/A		0	100	MGD			Field	13300	Flow Metering Structure	Y	Mount 4'-6" above ground
	FE	110	B	FE110B	I-101	South Fork Flow Metering Manhole Flow	FloDar Surface Radar Flow Sensor FloDar Surface			L-Bracket off Wall							Field	13300	Flow Metering Structure	N	Marsh McBirney FloDar
	FIT	110	B	FIT110B	I-101	South Fork Flow Metering Manhole Flow	Radar Flow Transmitter			N/A		0	100	MGD			Field	13300	Flow Metering Structure	Y	Mount 4'-6" above ground
	LE	120	A	LE120A	I-101	Existing Peachtree Creek Trunk Sewer Level Monitoring Manhole Sanitary Sewer Level	Ultrasonic Level Transducer			Suspended Transducer							Field	13300	Remote Level Monitoring Manhole	N	Suspend into manhole via 1" CVPC Pipe - narrow beam angle required (about 6 degrees) to allow both transmitters to function in the same manhole
	LIT	120	A	LIT120A	I-101	Existing Peachtree Creek Trunk Sewer Level Monitoring Manhole Sanitary Sewer Level	Ultrasonic Level Transmitter			N/A		0	90	Inches			Field	13300	Remote Level Monitoring Manhole	Y	Mount 4'-6" above ground
	LE	120	B	LE120B	I-101	Existing Peachtree Creek Trunk Sewer Level Monitoring Manhole Sanitary Sewer Level	Ultrasonic Level Transducer			Suspended Transducer							Field	13300	Remote Level Monitoring Manhole	N	Suspend into manhole via 1" CVPC Pipe - narrow beam angle required (about 6 degrees) to allow both transmitters to function in the same manhole
	LIT	120	B	LIT120B	I-101	Existing Peachtree Creek Trunk Sewer Level Monitoring Manhole Sanitary Sewer Level	Ultrasonic Level Transmitter			N/A		0	90	Inches			Field	13300	Remote Level Monitoring Manhole	Y	Mount 4'-6" above ground
	LE	201		LE201	I-102	Diversion Wet Well # 1 Level	Radar Level Transducer			Flanged	3 inch						Field	13300	Diversion Wet Well # 1	N	Flange mount on top of Diversion Wet Well
	LIT	201		LIT201	I-102	Diversion Wet Well # 1 Level	Radar Level Transmitter			N/A		0	39	Feet	Bottom EL 785 to top of concrete at 824 feet El.		Field	13300	Diversion Wet Well # 1	Y	Mount 4'-6" above ground
	LE	202		LE202	I-102	Diversion Wet Well # 1 Level	Radar Level Transducer			Flanged	3 inch						Field	13300	Diversion Wet Well # 1	N	Flange mount on top of Diversion Wet Well
	LIT	202		LIT202	I-102	Diversion Wet Well # 1 Level	Radar Level Transmitter			N/A		0	39	Feet	Bottom EL 785 to top of concrete at 824 feet El.		Field	13300	Diversion Wet Well # 1	Y	Mount 4'-6" above ground
	LSLL	203		LSLL203	I-102	Diversion Wet Well # 1 LowLow Level	Float Level Switch			Tie-Wrap to Support Pipe			788.33	Feet Elev.	Open on Falling Level		Field	13300	Diversion Wet Well # 1	N	Requires Intrinsic Safety Wiring
	LSLL	204		LSLL204	I-102	Diversion Wet Well # 1 LowLow Level	Float Level Switch			Tie-Wrap to Support Pipe			785.8	Feet Elev.	Open on Falling Level		Field	13300	Diversion Wet Well # 1	N	Requires Intrinsic Safety Wiring
	LSHH	205		LSHH205	I-102	Diverison Valve Room Sump High High Level	Float Level Switch			Tie-Wrap to Support Pipe			807.8 approx	Feet Elev.	Open on Rising Level		Field	13300	Diversion Valve Room Sump	N	Requires Intrinsic Safety Wiring
	FE	210		FE210	I-102	Diversion Wet Well # 1 Discharge Flow	Magneter Flow Transducer			Flanged	36 Inches						Field	13300	Diversion Valve Room	N	Flow Meter Vault ?
	FIT	210		FIT210	I-102	Diversion Wet Well # 1 Discharge Flow	Magneter Flow Transmitter			N/A		0	45	MGD			Field	13300	Diversion Valve Room	Y	Mount 4'-6" above ground
	AE	210		AE210	I-102	Combustible Gas Detection - Methane - Diversion Wet Well #1	Combustible Gas Sensor - Infrared Absorption			Pipe Stand							Field	13300	Diversion Wet Well # 1	N	Pipe Stand Bracket about 4 ft off Wet Well cover
	AIT	210		AIT210	I-102	Combustible Gas Detection - Methane - Diversion Wet Well #1	Combustible Gas Transmiter			N/A		0	100	% LEL	10% LEL - Methane		Panel	13300	Diversion Wet Well # 1	Y	located in Gas Monitoring Panel
	AY	210		AY210	I-102	Combustible Gas Detection - Methane - Diversion Wet Well #1	Combustible Gas Detector - Sample Pump			N/A							Panel	13300	Diversion Wet Well # 1	N	located in Gas Monitoring Panel
	XA	210	A	XA210A	I-102	Combustible Gas Detection - Diversion Wet Well #1	Audible Horn			N/A							Panel	13300	Diversion Wet Well # 1	N	located in Gas Monitoring Panel
	XL	210	A	XL210A	I-102	Combustible Gas Detection - Diversion Wet Well #1	Strobe Light			N/A							Panel	13300	Diversion Wet Well # 1	N	located in Gas Monitoring Panel

Liddell Drive Equalization Facility - Instrument list - Non-Vendor Furnished

I&C Specification: 13100 | Last Revised: 5/30/2012 | 6/24/2012 | 7/20/2012 | 8/27/2012 | 9/28/2012
Last Revision #: Preliminary | 90% Update | Additional Changes | Revised EQ Tank Desig Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	As Description	Manufacturer	Model No.	Connection Type	Connection Size	Calibration Low Range	Calibration High Range	Calibration Units	Calibration Notes	Supplier	Device Type	Spec Reference	Physical Location	Power Supply	Notes
	AE	211		AE211	I-102	Hydrogen Sulfide Gas Detection - Diversion Wet Well #1	H2S Gas Detector Sensor			Pipe Stand							Field	13300	Diversion Wet Well # 1	N	Pipe Stand Bracket about 4 ft off Wet Well cover
	AIT	211		AIT211	I-102	Hydrogen Sulfide Gas Detection - Diversion Wet Well #1	H2S Gas Detector Transmitter			N/A		0	30	PPM			Field	13300	Diversion Wet Well # 1	Y	located in Gas Monitoring Panel
	AY	211		AY211	I-102	Hydrogen Sulfide Gas Detection - Diversion Wet Well #1	H2S Gas Detector - Sample Pump			N/A							Field	13300	Diversion Wet Well # 1	N	located in Gas Monitoring Panel
	AE	212		AE212	I-102	Combustible Gas Detection - Petroleum - Diversion Wet Well #1	Combustible Gas Sensor - Infrared Absorption			Pipe Stand							Field	13300	Diversion Wet Well # 1	N	Pipe Stand Bracket about 4 ft off Wet Well cover
	AIT	212		AIT212	I-102	Combustible Gas Detection - Petroleum - Diversion Wet Well #1	Combustible Gas Transmitter			N/A		0	100	% LEL	10% LEL - Petroleum		Panel	13300	Diversion Wet Well # 1	Y	located in Gas Monitoring Panel
	AY	212		AY212	I-102	Combustible Gas Detection - Petroleum - Diversion Wet Well #1	Combustible Gas Detector - Sample Pump			N/A							Panel	13300	Diversion Wet Well # 1	N	located in Gas Monitoring Panel
	LE	301		LE301	I-103	Diversion Wet Well # 2 Level	Radar Level Transducer			Flanged	3 inch						Field	13300	Diversion Wet Well # 2	N	Flange mount on top of Diversion Wet Well
	LIT	301		LIT301	I-103	Diversion Wet Well # 2 Level	Radar Level Transmitter			N/A		*0*	*39*	*Feet*	*Bottom EL 785 to top of concrete at 824 feet EL*		Field	13300	Diversion Wet Well # 2	Y	Mount 4'-6" above ground
	LE	302		LE302	I-103	Diversion Wet Well # 2 Level	Radar Level Transducer			Flanged	3 inch						Field	13300	Diversion Wet Well # 2	N	Flange mount on top of Diversion Wet Well
	LIT	302		LIT302	I-103	Diversion Wet Well # 2 Level	Radar Level Transmitter			N/A		*0*	*39*	*Feet*	*Bottom EL 785 to top of concrete at 824 feet EL*		Field	13300	Diversion Wet Well # 2	Y	Mount 4'-6" above ground
	LSLL	303		LSLL303	I-103	Diversion Wet Well # 2 LowLow Level	Float Level Switch			Tie-Wrap to Support Pipe			788.33	Feet Elev.	Open on Falling Level		Field	13300	Diversion Wet Well # 2	N	Requires Intrinsic Safety Wiring
	LSLL	304		LSLL304	I-103	Diversion Wet Well # 2 LowLow Level	Float Level Switch			Tie-Wrap to Support Pipe			785.8	Feet Elev.	Open on Falling Level		Field	13300	Diversion Wet Well # 2	N	Requires Intrinsic Safety Wiring
	FE	**310**		**FE310**	I-103	Diversion Wet Well # 2 Discharge Flow	Magneter Flow Transducer			**Flanged**	**36 Inches**						Field	13300	**Diversion Facility**	N	Flow Meter Vault ?
	FIT	**310**		**FIT310**	I-103	Diversion Wet Well # 2 Discharge Flow	Magneter Flow Transmitter			N/A		**0**	**45**	**MGD**			Field	13300	**Diversion Facility**	Y	Mount 4'-6" above ground
	AE	310		AE310	I-103	Combustible Gas Detection - Methane - Diversion Wet Well # 2	Combustible Gas Sensor - Infrared Absorption			Pipe Stand							Field	13300	Diversion Wet Well # 2	N	Pipe Stand Bracket about 4 ft off Wet Well cover
	AIT	310		AIT310	I-103	Combustible Gas Detection - Methane - Diversion Wet Well # 2	Combustible Gas Transmitter			N/A		0	100	% LEL	10% LEL - Methane		Panel	13300	Diversion Wet Well # 2	Y	located in Gas Monitoring Panel
	AY	310		AY310	I-103	Combustible Gas Detection - Methane - Diversion Wet Well # 2	Combustible Gas Detector - Sample Pump			N/A							Panel	13300	Diversion Wet Well # 2	N	located in Gas Monitoring Panel
	XA	310	A	XA310A	I-103	Combustible Gas Detection - Diversion Wet Well # 2	Audible Horn			N/A							Panel	13300	Diversion Wet Well # 2	N	located in Gas Monitoring Panel
	XL	310	A	XL310A	I-103	Combustible Gas Detection - Diversion Wet Well # 2	Strobe Light			N/A							Panel	13300	Diversion Wet Well # 2	N	located in Gas Monitoring Panel
	AE	311		AE311	I-103	Hydrogen Sulfide Gas Detection - Diversion Wet Well # 2	H2S Gas Detector Sensor			Pipe Stand							Field	13300	Diversion Wet Well # 2	N	Pipe Stand Bracket about 4 ft off Wet Well cover
	AIT	311		AIT311	I-103	Hydrogen Sulfide Gas Detection - Diversion Wet Well # 2	H2S Gas Detector Transmitter			N/A		0	30	PPM			Field	13300	Diversion Wet Well # 2	Y	located in Gas Monitoring Panel
	AY	311		AY311	I-103	Hydrogen Sulfide Gas Detection - Diversion Wet Well # 2	H2S Gas Detector - Sample Pump			N/A							Field	13300	Diversion Wet Well # 2	N	located in Gas Monitoring Panel
	AE	312		AE312	I-103	Combustible Gas Detection - Petroleum - Diversion Wet Well # 2	Combustible Gas Sensor - Infrared Absorption			Pipe Stand							Field	13300	Diversion Wet Well # 2	N	Pipe Stand Bracket about 4 ft off Wet Well cover
	AIT	312		AIT312	I-103	Combustible Gas Detection - Petroleum - Diversion Wet Well # 2	Combustible Gas Transmitter			N/A		0	100	% LEL	10% LEL - Petroleum		Panel	13300	Diversion Wet Well # 2	Y	located in Gas Monitoring Panel
	AY	312		AY312	I-103	Combustible Gas Detection - Petroleum - Diversion Wet Well # 2	Combustible Gas Detector - Sample Pump			N/A							Panel	13300	Diversion Wet Well # 2	N	located in Gas Monitoring Panel

Liddell Drive Equalization Facility - Instrument list - Non-Vendor Furnished

I&C Specification: 13100

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Desig Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	As Description	Manufacturer	Model No.	Connection Type	Connection Size	Calibration Low Range	Calibration High Range	Calibration Units	Calibration Notes	Supplier	Device Type	Spec Reference	Physical Location	Power Supply	Notes
	LE	501		LE501	I-104	Equalization Tank Level	Radar Level Transducer			Flanged	3 inch						Field	13300	Equalization Tank Top	N	Flange mount on top of Equalization Tank
	LIT	501		LIT501	I-104	Equalization Tank Level	Radar Level Transmitter			N/A		0	61	Feet	Bottom EL 796.5 to 1 foot above overflow 856 Ft EL		Field	13300	Equalization Tank	Y	Mount 4'-6" above ground
	LSH	501		LSH501	I-104	Equalization Tank High Level	Capacitance High Level Switch			Threaded	1" NPT		855	Feet Elev.	Open on Rising Level		Field	13300	Equalization Tank Top	Y	Explosion proof or Intrinsic Safety
	LSHH	501		LSHH501	I-104	Equalization Tank High High Level	Capacitance High High Level Switch			Threaded	1" NPT		855.5	Feet Elev.	Open on Falling Level		Field	13300	Equalization Tank Top	Y	Explosion proof or Intrinsic Safety
	LSHH	502		LSHH502	I-104	Equalization Pipeline Junction Box High High Level	Float Level Switch			Tie-Wrap to Support Pipe			867	Feet Elev.	Open on Rising Level		Field	13300	Flow Return Junction Box	N	Requires Intrinsic Safety Wiring
	PSH	501		PSH501	I-104	Jet Mix Pump #1 Discharge High Pressure	Diaphragm Actuated Pressure Switch w/Diaphragm Seal			Threaded	1" NPT		15	PSIG	Open on Rising Pressure		Field	13300	Jet Mixing Pump Station	N	
	PSH	502		PSH502	I-104	Jet Mix Pump #2 Discharge High Pressure	Diaphragm Actuated Pressure Switch w/Diaphragm Seal			Threaded	1" NPT		15	PSIG	Open on Rising Pressure		Field	13300	Jet Mixing Pump Station	N	
	LSHH	503		LSHH503	I-104	Jet Mix Pump Station Washdown Sump High High Level	Float Level Switch			Tie-Wrap to Support Pipe			787.8 approx	Feet Elev.	Open on Rising Level		Field	13300	Jet Mixing Pump Station	N	Requires Intrinsic Safety Wiring
	~~LSHH~~	~~504~~		~~LSHH504~~	~~I-104~~	~~Equalization Facility Valve Vault Sump High High Level~~	~~Float Level Switch~~			~~Tie-Wrap to Support Pipe~~			~~XXX~~	~~Feet Elev.~~	~~Open on Rising Level~~		~~Field~~	~~13300~~	~~Equalization Valve Vault~~	~~N~~	~~Requires Intrinsic Safety Wiring~~
	~~FE~~	~~503~~		~~FE503~~	~~I-105~~	~~Equalization Tank Discharge Flow~~	~~Magneter Flow Transducer~~			~~Flanged~~	~~48 Inches~~						~~Field~~	~~13300~~	~~Equalization Valve Vault~~	~~N~~	~~Flow Meter Vault 2~~
	~~FIT~~	~~503~~		~~FIT503~~	~~I-105~~	~~Equalization Tank Discharge Flow~~	~~Magneter Flow Transmitter~~			~~N/A~~		~~0~~	~~40~~	~~MGD~~			~~Field~~	~~13300~~	~~Equalization Valve Vault~~	~~Y~~	~~Mount 4'-6" above ground~~
	FE	531		FE531	I-105	Equalized Flow Return Pump # 1 Discharge Flow	Magneter Flow Transducer			Flanged	16 Inches						Field	13300	Equlization Flow Return Pump Station	N	
	FIT	531		FIT531	I-105	Equalized Flow Return Pump # 1 Discharge Flow	Magneter Flow Transmitter			N/A		0	7,000	GPM			Field	13300	Equalization Flow Return Pump Station	Y	Mount 4'-6" above ground
	FE	532		FE532	I-105	Equalized Flow Return Pump # 2 Discharge Flow	Magneter Flow Transducer			Flanged	16 Inches						Field	13300	Equalization Flow Return Pump Station	N	
	FIT	532		FIT532	I-105	Equalized Flow Return Pump # 2 Discharge Flow	Magneter Flow Transmitter			N/A		0	7,000	GPM			Field	13300	Equlization Flow Return Pump Station	Y	Mount 4'-6" above ground
	FE	533		FE533	I-105	Equalized Flow Return Pump # 3 Discharge Flow	Magneter Flow Transducer			Flanged	16 Inches						Field	13300	Equalization Flow Return Pump Station	N	
	FIT	533		FIT533	I-105	Equalized Flow Return Pump # 3 Discharge Flow	Magneter Flow Transmitter			N/A		0	7,000	GPM			Field	13300	Equalization Flow Return Pump Station	Y	Mount 4'-6" above ground
	AE	410		AE410	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber Inlet	H2S Gas Detector Sensor			Control Panel							Field	13300	Diversion Facility Odor Control Scrubber OC-401	N	located in Gas Monitoring Panel

Liddell Drive Equalization Facility - Instrument list - Non-Vendor Furnished

I&C Specification: 13100

Last Revised:	5/30/2012	6/24/2012	7/20/2012	8/27/2012	9/28/2012
Last Revision #:	Preliminary	90% Update	Additional Changes	Revised EQ Tank Desig	Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	As Description	Manufacturer	Model No.	Connection Type	Connection Size	Calibration Low Range	Calibration High Range	Calibration Units	Calibration Notes	Supplier	Device Type	Spec Reference	Physical Location	Power Supply	Notes
	AIT	410		AIT410	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber Inlet	H2S Gas Transmiiter			N/A		0	30	PPM	H2S		Panel	13300	Diversion Facility Odor Control Scrubber OC-401	Y	
	AY	410		AY410	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber Inlet	H2S Gas Detector - Sample Pump			N/A							Panel	13300	Diversion Facility Odor Control Scrubber OC-401	N	located in Gas Monitoring Panel
	AE	411		AE411	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber	Combustible Gas Sensor - Infrared Absorption			Pipe Stand							Field	13300	Diversion Facility Odor Control Scrubber OC-401	N	Mount 4'-6" above ground
	AIT	411		AIT411	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber	Combustible Gas Transmiiter			N/A		0	100	% LEL	10% LEL - Methane		Panel	13300	Diversion Facility Odor Control Scrubber OC-401	Y	
	AE	412		AE412	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber after Filter Bed	H2S Gas Detector Sensor			Control Panel							Field	13300	Diversion Facility Odor Control Scrubber OC-401	N	located in Gas Monitoring Panel
	AIT	412		AIT412	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber after Filter Bed	H2S Gas Transmiiter			N/A		0	30	PPM	H2S		Panel	13300	Diversion Facility Odor Control Scrubber OC-401	Y	
	AY	412		AY412	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber after Filter Bed	H2S Gas Detector - Sample Pump			N/A							Panel	13300	Diversion Facility Odor Control Scrubber OC-401	N	located in Gas Monitoring Panel
	AE	413		AE413	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber Outlet	H2S Gas Detector Sensor			Control Panel							Field	13300	Diversion Facility Odor Control Scrubber OC-401	N	located in Gas Monitoring Panel
	AIT	413		AIT413	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber Outlet	H2S Gas Transmiiter			N/A		0	30	PPM	H2S		Panel	13300	Diversion Facility Odor Control Scrubber OC-401	Y	
	AY	413		AY413	I-106	Combustible Gas Detection - Methane - Diversion Facility Odor Control Scrubber Outlet	H2S Gas Detector - Sample Pump			N/A							Panel	13300	Diversion Facility Odor Control Scrubber OC-401	N	located in Gas Monitoring Panel
	FSL	415		FSL415	I-106	Diversion Facility Valve Room Low Ventillation Air Flow	Thermal Air Flow Switch			Threaded	1" NPT		2,000	SCFM	Open on falling flow		Field	13300	Discharge of Exhaust Fans EF-301 and 302 (H3-102)	Y	Hardwire to Loss of Ventilation Alarm System
	AE	510		AE510	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber Inlet	H2S Gas Detector Sensor			Control Panel							Field	13300	Equalization Facility Odor Control Scrubber OC-501	N	located in Gas Monitoring Panel

Liddell Drive Equalization Facility - Instrument list - Non-Vendor Furnished

1&C Specification: 13100

Last Revised:	5/30/2012	6/24/2012	7/20/2012	8/27/2012	9/28/2012
Last Revision #:	Preliminary	90% Update	Additional Changes	Revised EQ Tank Desig	Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	As Description	Manufacturer	Model No.	Connection Type	Connection Size	Calibration Low Range	Calibration High Range	Calibration Units	Calibration Notes	Supplier	Device Type	Spec Reference	Physical Location	Power Supply	Notes
	AIT	510		AIT510	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber Inlet	H2S Gas Transmiiter			N/A		0	30	PPM	H2S		Panel	13300	Equalization Facility Odor Control Scrubber OC-501	Y	
	AY	510		AY510	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber Inlet	H2S Gas Detector - Sample Pump			N/A							Panel	13300	Equalization Facility Odor Control Scrubber OC-501	N	located in Gas Monitoring Panel
	AE	511		AE511	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber	Combustible Gas Sensor - Infrared Absorption			Pipe Stand							Field	13300	Equalization Facility Odor Control Scrubber OC-501	N	Mount 4'-6" above ground
	AIT	511		AIT511	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber	Combustible Gas Transmiiter			N/A		0	100	% LEL	10% LEL - Methane		Panel	13300	Equalization Facility Odor Control Scrubber OC-501	Y	
	AE	512		AE512	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber after Filter Bed	H2S Gas Detector Sensor			Control Panel							Field	13300	Equalization Facility Odor Control Scrubber OC-501	N	located in Gas Monitoring Panel
	AIT	512		AIT512	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber after Filter Bed	H2S Gas Transmiiter			N/A		0	30	PPM	H2S		Panel	13300	Equalization Facility Odor Control Scrubber OC-501	Y	
	AY	512		AY512	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber after Filter Bed	H2S Gas Detector - Sample Pump			N/A							Panel	13300	Equalization Facility Odor Control Scrubber OC-501	N	located in Gas Monitoring Panel
	AE	513		AE513	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber Outlet	H2S Gas Detector Sensor			Control Panel							Field	13300	Equalization Facility Odor Control Scrubber OC-501	N	located in Gas Monitoring Panel
	AIT	513		AIT513	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber Outlet	H2S Gas Transmiiter			N/A		0	30	PPM	H2S		Panel	13300	Equalization Facility Odor Control Scrubber OC-501	Y	
	AY	513		AY513	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber Outlet	H2S Gas Detector - Sample Pump			N/A							Panel	13300	Equalization Facility Odor Control Scrubber OC-501	N	located in Gas Monitoring Panel
	FSL	515	A	FSL515A	I-107	Equalization Facility Jet Mix Pump Room Low Ventillation Air Flow	Thermal Air Flow Switch			Threaded	1" NPT		11,000	SCFM	Open on falling flow		Field	13300	Discharge of Exhaust Fans EF-701 and 702 (H7-101)	Y	Hardwire to Loss of Ventilation Alarm Panel LCP-515
	FSL	515	B	FSL515B	I-107	Equalization Facility Jet Mix Pump Room Low Ventillation Air Flow	Thermal Air Flow Switch			Threaded	1" NPT		11,000	SCFM	Open on falling flow		Field	13300	Discharge of Exhaust Fans EF-701 and 702 (H7-101)	Y	Hardwire to Loss of Ventilation Alarm Panel LCP-515
	FE	510		FE510	I-108	Equalization Tank Flushing Water Flow	Magneter Flow Transducer			Flanged	8 Inches						Field	13300	Jet Mixing Pump Station	N	Flow Meter Vault ?

Liddell Drive Equalization Facility - Instrument list - Non-Vendor Furnished

I&C Specification: 13100

Last Revised:	5/30/2012	6/24/2012	7/20/2012	8/27/2012	9/28/2012
Last Revision #:	Preliminary	90% Update	Additional Changes	Revised EQ Tank Desig	Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	As Description	Manufacturer	Model No.	Connection Type	Connection Size	Calibration Low Range	Calibration High Range	Calibration Units	Calibration Notes	Supplier	Device Type	Spec Reference	Physical Location	Power Supply	Notes
	FIT	510		FIT510	I-108	Equalization Tank Flushing Water Flow	Magneter Flow Transmitter			N/A		0	2000	GPM			Field	13300	Jet Mixing Pump Station	Y	Mount 4'-6" above ground

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	HSO	102	C	HSO102C	I-101	Diversion Structure # 2 Diversion Gate # 3 Open Command	Motorized Actuntor Open Command	Diversion Structure #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	102	C	HSC102C	I-101	Diversion Structure # 2 Diversion Gate # 3 Closed Command	Motorized Actuntor Close Command	Diversion Structure #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	102	C	ZIO102C	I-101	Diversion Structure # 2 Diversion Gate # 3 Open Position	Open Limit Switch	Diversion Structure #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	102	C	ZIC102C	I-101	Diversion Structure #1 Diversion Gate # 3 Closed Position	Closed Limit Switch	Diversion Structure #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	102	C	YN102C	I-101	Diversion Structure #2 Diversion Gate # 3 Local/Remote Status	Local/Remote Switch Status	Diversion Structure #2	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	FI	110	A	FI110A	I-101	South Fork Flow Metering Manhole Flow	FloDar Surface Radar Flow Transmitter	Flow Metering Manhole	AI	24V DC	SCADA	Y	No	SCADA			0	100	MGD	Absolute			Y	
	FI	110	B	FI110B	I-101	South Fork Flow Metering Manhole Flow	FloDar Surface Radar Flow Transmitter	Flow Metering Manhole	AI	24V DC	SCADA	Y	No	SCADA			0	100	MGD	Absolute			Y	
	LI	120	A	LI120A	I-101	Existing Peachtree Creek Trunk Sewer Level Monitoring Manhole Sanitary Sewer Level	Ultrasonic Level Transmitter	Remote Level Monitoring Manhole	AI	24V DC	RTU Panel	Y	No	SCADA			0	90	Inches	Absolute			Y	via Telemetry RTU at existing Site- Monitored by both Diversion Facility and Equalization Facility PLC's
	LI	120	B	LI120B	I-101	Existing Peachtree Creek Trunk Sewer Level Monitoring Manhole Sanitary Sewer Level	Ultrasonic Level Transmitter	Remote Level Monitoring Manhole	AI	24V DC	RTU Panel	Y	No	SCADA			0	90	Inches	Absolute			Y	via Telemetry RTU at existing Site- Monitored by both Diversion Facility and Equalization Facility PLC's
	UA	199		UA199	I-101	Diversion Facility Electrical Building Fire Alarm System Common Trouble Status	Common Trouble Status Contact	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Fire Alarm Panel
	HSO	201		HSO201	I-102	Diversion Wet Well # 1 Isolation Gate # 1 Open Command	Motorized Actuator Open Command	Diversion Wet Well #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	201		HSC201	I-102	Diversion Wet Well # 1 Isolation Gate # 1 Closed Command	Motorized Actuator Close Command	Diversion Wet Well #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	201		ZIO201	I-102	Diversion Wet Well #1 Isolation Gate # 1 Open Position	Open Limit Switch	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	201		ZIC201	I-102	Diversion Wet Well #1 Isolation Gate # 1 Closed Position	Closed Limit Switch	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	201		YN201	I-102	Diversion Wet Well #1 Isolation Gate # 1 Local/Remote Status	Local/Remote Switch Status	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	202		HSO202	I-102	Diversion Wet Well # 1 Isolation Gate # 2 Open Command	Motorized Actuator Open Command	Diversion Wet Well #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	202		HSC202	I-102	Diversion Wet Well # 1 Isolation Gate # 2 Closed Command	Motorized Actuator Close Command	Diversion Wet Well #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	202		ZIO202	I-102	Diversion Wet Well #1 Isolation Gate # 2 Open Position	Open Limit Switch	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	202		ZIC202	I-102	Diversion Wet Well #1 Isolation Gate # 2 Closed Position	Closed Limit Switch	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	202		YN202	I-102	Diversion Wet Well #1 Isolation Gate # 2 Local/Remote Status	Local/Remote Switch Status	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	203		HSO203	I-102	Diversion Wet Well Interconnection Sluice Gate Open Command	Motorized Actuntor Open Command	Diversion Wet Well #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	203		HSC203	I-102	Diversion Wet Well Interconnection Sluice Gate Closed Command	Motorized Actuntor Close Command	Diversion Wet Well #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	203		ZIO203	I-102	Diversion Wet Well Interconnection Sluice Gate Open Position	Open Limit Switch	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	HSO	101	A	HSO101A	I-101	Diversion Structure # 1 Diversion Gate # 1 Open Command	Motorized Actuator Open Command	Diversion Structure #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	101	A	HSC101A	I-101	Diversion Structure # 1 Diversion Gate # 1 Closed Command	Motorized Actuator Close Command	Diversion Structure #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	101	A	ZIO101A	I-101	Diversion Structure #1 Diversion Gate # 1 Open Position	Open Limit Switch	Diversion Structure #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	101	A	ZIC101A	I-101	Diversion Structure #1 Diversion Gate # 1 Closed Position	Closed Limit Switch	Diversion Structure #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	101	A	YN101A	I-101	**Diversion Structure #1 Diversion Gate # 1 Local/Remote Status**	**Local/Remote Switch Status**	**Diversion Structure #1**	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	101	B	HSO101B	I-101	Diversion Structure # 1 Diversion Gate # 2 Open Command	Motorized Actuator Open Command	Diversion Structure #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	101	B	HSC101B	I-101	Diversion Structure # 1 Diversion Gate # 2 Closed Command	Motorized Actuator Close Command	Diversion Structure #1	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	101	B	ZIO101B	I-101	Diversion Structure # 1 Diversion Gate # 2 Open Position	Open Limit Switch	Diversion Structure #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	101	B	ZIC101B	I-101	Diversion Structure # 1 Diversion Gate # 2 Closed Position	Closed Limit Switch	Diversion Structure #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	101	B	YN101B	I-101	**Diversion Structure #1 Diversion Gate # 2 Local/Remote Status**	**Local/Remote Switch Status**	**Diversion Structure #1**	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	101	C	HSO101C	I-101	**Diversion Structure # 1 Diversion Gate # 3 Open Command**	**Motorized Actuator Open Command**	**Diversion Structure #1**	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	101	C	HSC101C	I-101	**Diversion Structure # 1 Diversion Gate # 3 Closed Command**	**Motorized Actuator Close Command**	**Diversion Structure #1**	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	101	C	ZIO101C	I-101	**Diversion Structure #1 Diversion Gate # 3 Open Position**	**Open Limit Switch**	**Diversion Structure #1**	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	101	C	ZIC101C	I-101	**Diversion Structure #1 Diversion Gate # 3 Closed Position**	**Closed Limit Switch**	**Diversion Structure #1**	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	101	A	YN101C	I-101	**Diversion Structure #1 Diversion Gate # 3 Local/Remote Status**	**Local/Remote Switch Status**	**Diversion Structure #1**	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	102	A	HSO102A	I-101	Diversion Structure # 2 Diversion Gate # 1 Open Command	Motorized Actuator Open Command	Diversion Structure #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	102	A	HSC102A	I-101	Diversion Structure # 2 Diversion Gate # 1 Closed Command	Motorized Actuator Close Command	Diversion Structure #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	102	A	ZIO102A	I-101	Diversion Structure # 2 Diversion Gate # 1 Open Position	Open Limit Switch	Diversion Structure #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	102	A	ZIC102A	I-101	Diversion Structure #1 Diversion Gate # 1 Closed Position	Closed Limit Switch	Diversion Structure #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	102	A	YN102A	I-101	**Diversion Structure #2 Diversion Gate # 1 Local/Remote Status**	**Local/Remote Switch Status**	**Diversion Structure #2**	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	102	B	HSO102B	I-101	Diversion Structure # 2 Diversion Gate # 2 Open Command	Motorized Actuator Open Command	Diversion Structure #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	102	B	HSC102B	I-101	Diversion Structure # 2 Diversion Gate # 2 Closed Command	Motorized Actuator Close Command	Diversion Structure #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	102	B	ZIO102B	I-101	Diversion Structure # 2 Diversion Gate # 2 Open Position	Open Limit Switch	Diversion Structure #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	102	B	ZIC102B	I-101	Diversion Structure # 2 Diversion Gate # 2 Closed Position	Closed Limit Switch	Diversion Structure #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	102	B	YN102B	I-101	**Diversion Structure #2 Diversion Gate # 2 Local/Remote Status**	**Local/Remote Switch Status**	**Diversion Structure #2**	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display			Alarms			Trend / Record	Notes
																	Low Range	High Range	Units	Type	Low	High		
	ZIC	203		ZIC203	I-102	Diversion Wet Well Interconnection Sluice Gate Closed Position	Closed Limit Switch	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	203		YN203	I-102	Diversion Wet Well Interconnection Sluice Gate Local/Remote Status	Local/Remote Switch Status	Diversion Wet Well #1	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	MN	201	A	MN201A	I-102	Diversion Wet Well #1 Sludge Grinder # 1	"M" Contact	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	Vendor Furnished Local Control Panel
	XA	201	A	XA201A	I-102	Diversion Wet Well #1 Sludge Grinder # 1	Common Trouble Status Contact	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Vendor Furnished Local Control Panel
	MC	201	A	MC201A	I-102	Diversion Wet Well #1 Sludge Grinder # 1	Motor Start/Stop	Diversion Wet Well # 1	DO	120 VAC	LCP	N	No	SCADA	Start	Stop							N	Vendor Furnished Local Control Panel
	YN	201	AA	YN201AA	I-102	Diversion Wet Well #1 Sludge Grinder # 1	HOR Remote Status	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	Vendor Furnished Local Control Panel
	MN	202	A	MN202A	I-102	Diversion Wet Well #1 Sludge Grinder # 2	"M" Contact	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	Vendor Furnished Local Control Panel
	XA	202	A	XA202A	I-102	Diversion Wet Well #1 Sludge Grinder # 2	Common Trouble Status Contact	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Vendor Furnished Local Control Panel
	MC	202	A	MC202A	I-102	Diversion Wet Well #1 Sludge Grinder # 2	Motor Start/Stop	Diversion Wet Well # 1	DO	120 VAC	LCP	N	No	SCADA	Start	Stop							N	Vendor Furnished Local Control Panel
	YN	202	AA	YN202AA	I-102	Diversion Wet Well #1 Sludge Grinder # 2	HOR Remote Status	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							Y	Vendor Furnished Local Control Panel
	LI	201		LI201	I-102	Diversion Wet Well # 1 Level	Radar Level Transmitter	Facility Electrical Building	AI	24V DC	SCADA	Y	No	SCADA			785	824	Feet EL	Absolute			Y	from Level Monitoring Panel
	LI	202		LI202	I-102	Diversion Wet Well # 1 Level	Radar Level Transmitter	Facility Electrical Building	AI	24V DC	SCADA	Y	No	SCADA			785	824	Feet EL	Absolute			Y	from Level Monitoring Panel
	LALL	203		LALL203	I-102	Diversion Wet Well # 1 LowLow Level	Float Level Switch	Facility Electrical Building	DI	120 VAC	SCADA	N	Yes	SCADA	Normal	LowLow							Y	from Level Monitoring Panel
	LALL	204		LALL204	I-102	Diversion Wet Well # 1 LowLow Level	Float Level Switch	Facility Electrical Building	DI	120 VAC	SCADA	N	Yes	SCADA	Normal	LowLow							Y	from Level Monitoring Panel
	LAHH	205		LAHH205	I-102	Diverison Valve Room Sump High High Level	Float Level Switch	Diversion Valve Room Sump	DI	120 VAC	SCADA	N	Y	SCADA	Normal	HHH							Y	
	MN	201		MN201	I-102	Diversion Wet Well #1 Diversion Pump # 1 Running Status	"M" Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	201		XA201	I-102	Diversion Wet Well #1 Diversion Pump # 1 Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	201		MC201	I-102	Diversion Wet Well #1 Diversion Pump # 1 Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	201	A	YN201A	I-102	Diversion Wet Well #1 Diversion Pump # 1 VFD HOR in Remote Status	HOR Remote Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	YN	201	B	YN201B	I-102	Diversion Wet Well #1 Diversion Pump # 1 Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	
	SI	201		SI201	I-102	Diversion Wet Well #1 Diversion Pump # 1 Speed Feedback	VFD Speed Feedback	Diversion Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	201		SC201	I-102	Diversion Wet Well #1 Diversion Pump # 1 Speed Control	VFD Speed Control	Diversion Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	UA	201		UA201	I-102	Diversion Wet Well #1 Diversion Pump # 1 Surge Control Panel Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	From Local Surge Control Panel PIC-201
	MN	202		MN202	I-102	Diversion Wet Well #1 Diversion Pump # 2 Running Status	"M" Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

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Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display			Alarms			Trend Record	Notes
																	Low Range	High Range	Units	Type	Low	High		
	XA	202		XA202	I-102	Diversion Wet Well #1 Diversion Pump # 2 Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	202		MC202	I-102	Diversion Wet Well #1 Diversion Pump # 2 Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	202	A	YN202A	I-102	Diversion Wet Well #1 Diversion Pump # 2 VFD HOR in Remote Status	HOR Remote Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	YN	202	B	YN202B	I-102	Diversion Wet Well #1 Diversion Pump # 2 Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	
	SI	202		SI202	I-102	Diversion Wet Well #1 Diversion Pump # 2 Speed Feedback	VFD Speed Feedback	Diversion Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	202		SC202	I-102	Diversion Wet Well #1 Diversion Pump # 2 Speed Control	VFD Speed Control	Diversion Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	UA	202		UA202	I-102	Diversion Wet Well #1 Diversion Pump # 2 Surge Control Panel Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	From Local Surge Control Panel PIC-202
	MN	203		MN203	I-102	Diversion Wet Well #1 Diversion Pump # 3 Running Status	"M" Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	203		XA203	I-102	Diversion Wet Well #1 Diversion Pump # 3 Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	203		MC203	I-102	Diversion Wet Well #1 Diversion Pump # 3 Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	203	A	YN203A	I-102	Diversion Wet Well #1 Diversion Pump # 3 VFD HOR in Remote Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	
	YN	203	B	YN203B	I-102	Diversion Wet Well #1 Diversion Pump # 3 Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	
	SI	203		SI203	I-102	Diversion Wet Well #1 Diversion Pump # 3 Speed Feedback	VFD Speed Feedback	Diversion Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	203		SC203	I-102	Diversion Wet Well #1 Diversion Pump # 3 Speed Control	VFD Speed Control	Diversion Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	UA	203		UA203	I-102	Diversion Wet Well #1 Diversion Pump # 3 Surge Control Panel Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	From Local Surge Control Panel PIC-203
	MN	204		MN204	I-102	Diversion Wet Well #1 Drainage Pump Running Status	"M" Contnet	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	204		XA204	I-102	Diversion Wet Well #1 Drainage Pump Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	204		MC204	I-102	Diversion Wet Well #1 Drainage Pump Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	204	A	YN204A	I-102	Diversion Wet Well #1 Drainage Pump RVSS HOR in Remote Status	HOR Remote Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	YN	204	B	YN204B	I-102	Diversion Wet Well #1 Drainage Pump Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	HSO	203	A	HSO203A	I-102	Return Flow to South Forks Sanitary Sewer Motorized Isolation Valve - Open Command	Motorized Valve Actuator Open Command	Diversion Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	203	A	HSC203A	I-102	Return Flow to South Forks Sanitary Sewer Motorized Isolation Valve - Closed Command	Motorized Valve Actuator Close Command	Diversion Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	203	A	ZIO203A	I-102	Return Flow to South Forks Sanitary Sewer Motorized Isolation Valve - Open Position	Open Limit Switch	Diversion Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	203	A	ZIC203A	I-102	Return Flow to South Forks Sanitary Sewer Motorized Isolation Valve - Closed Position	Closed Limit Switch	Diversion Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	203	A	YN203A	I-102	Return Flow to South Forks Sanitary Sewer Motorized Isolation Valve Local/Remote Status	Local/Remote Switch Status	Diversion Facility	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	FI	210		FI1210	I-102	Diversion Wet Well # 1 Discharge Flow	Magneter Flow Transmitter	Diversion Valve Room	AI	24V DC	SCADA	Y	No	SCADA			0	45	MGD	Absolute			Y	flow metering vault ?
	AI	210		AI210	I-102	Combustible Gas Detection - Methane - Diversion Wet Well #1	Combustible Gas Transmitter	Diversion Wet Well # 1	AI	24V DC	SCADA	Y	No	SCADA			0	100	% LEL				Y	Gas Monitoring Panel
	XA	210		XA210	I-102	Combustible Gas Detection - Methane - Diversion Wet Well #1	Common Trouble Status Contact	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Gas Monitoring Panel
	AI	211		AI211	I-102	Hydrogen Sulfide Gas Detection - Diversion Wet Well #1	H2S Gas Detector Transmitter	Diversion Wet Well # 1	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	Gas Monitoring Panel
	XA	211		XA211	I-102	Hydrogen Sulfide Gas Detection - Diversion Wet Well #1	Common Trouble Status Contact	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Gas Monitoring Panel
	AI	212		AI212	I-102	Combustible Gas Detection - Petroleum - Diversion Wet Well #1	Combustible Gas Transmitter	Diversion Wet Well # 1	AI	24V DC	SCADA	Y	No	SCADA			0	100	% LEL				Y	Gas Monitoring Panel
	XA	212		XA212	I-102	Combustible Gas Detection - Petroleum - Diversion Wet Well #1	Common Trouble Status Contact	Diversion Wet Well # 1	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Gas Monitoring Panel
	HSO	301		HSO301	I-103	Diversion Wet Well # 2 Isolation Gate # 1 Open Command	Motorized Actuator Open Command	Diversion Wet Well #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	301		HSC301	I-103	Diversion Wet Well # 2 Isolation Gate # 1 Closed Command	Motorized Actuator Close Command	Diversion Wet Well #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	301		ZIO301	I-103	Diversion Wet Well # 2 Isolation Gate # 1 Open Position	Open Limit Switch	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	301		ZIC301	I-103	Diversion Wet Well # 2 Isolation Gate # 1 Closed Position	Closed Limit Switch	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	301		YN301	I-103	Diversion Wet Well #2 Isolation Gate # 1 Local/Remote Status	Local/Remote Switch Status	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	302		HSO302	I-103	Diversion Wet Well # 2 Isolation Gate # 2 Open Command	Motorized Actuator Open Command	Diversion Wet Well #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	302		HSC302	I-103	Diversion Wet Well # 2 Isolation Gate # 2 Closed Command	Motorized Actuator Close Command	Diversion Wet Well #2	DO	120 VAC	GATE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	302		ZIO302	I-103	Diversion Wet Well # 2 Isolation Gate # 2 Open Position	Open Limit Switch	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	302		ZIC302	I-103	Diversion Wet Well # 2 Isolation Gate # 2 Closed Position	Closed Limit Switch	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	302		YN302	I-103	Diversion Wet Well #2 Isolation Gate # 2 Local/Remote Status	Local/Remote Switch Status	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	MN	301	A	MN301A	I-103	Diversion Wet Well # 2 Sludge Grinder # 1	"M" Contact	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	Vendor Furnished Local Control Panel
	XA	301	A	XA301A	I-103	Diversion Wet Well # 2 Sludge Grinder # 1	Common Trouble Status Contact	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Vendor Furnished Local Control Panel

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 — 6/24/2012 — 7/20/2012 — 8/27/2012 — 9/28/2012

Last Revision #: Preliminary — 90% Update — Additional Changes — Revised EQ Tank Design — Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	MC	301	A	MC301A	I-103	Diversion Wet Well # 2 Sludge Grinder # 1	Motor Start/Stop	Diversion Wet Well #2	DO	120 VAC	LCP	N	No	SCADA	Start	Stop							N	Vendor Furnished Local Control Panel
	YN	301	AA	YN301AA	I-103	Diversion Wet Well # 2 Sludge Grinder # 1	HOR Remote Status	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	Vendor Furnished Local Control Panel
	MN	302	A	MN302A	I-103	Diversion Wet Well # 2 Sludge Grinder # 2	"M" Contact	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	Vendor Furnished Local Control Panel
	XA	302	A	XA302A	I-103	Diversion Wet Well # 2 Sludge Grinder # 2	Common Trouble Status Contact	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Vendor Furnished Local Control Panel
	MC	302	A	MC302A	I-103	Diversion Wet Well # 2 Sludge Grinder # 2	Motor Start/Stop	Diversion Wet Well #2	DO	120 VAC	LCP	N	No	SCADA	Start	Stop							N	Vendor Furnished Local Control Panel
	YN	302	AA	YN302AA	I-103	Diversion Wet Well # 2 Sludge Grinder # 2	HOR Remote Status	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	Vendor Furnished Local Control Panel
	LI	301		LI301	I-103	Diversion Wet Well # 2 Level	Radar Level Transmitter	Facility Electrical Building	AI	24V DC	SCADA	Y	No	SCADA			785	824	Feet El.	Absolute			Y	from Level Monitoring Panel
	LI	302		LI302	I-103	Diversion Wet Well # 2 Level	Radar Level Transmitter	Facility Electrical Building	AI	24V DC	SCADA	Y	No	SCADA			785	824	Feet El.	Absolute			Y	from Level Monitoring Panel
	LALL	303		LALL303	I-103	Diversion Wet Well # 2 LowLow Level	Float Level Switch	Facility Electrical Building	DI	120 VAC	SCADA	N	Yes	SCADA	Normal	LowLow							Y	from Level Monitoring Panel
	LALL	304		LALL304	I-103	Diversion Wet Well # 2 LowLow Level	Float Level Switch	Facility Electrical Building	DI	120 VAC	SCADA	N	Yes	SCADA	Normal	LowLow							Y	from Level Monitoring Panel
	MN	301		MN301	I-103	Diversion Wet Well #2 Diversion Pump # 1 Running Status	"M" Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	301		XA301	I-103	Diversion Wet Well #2 Diversion Pump # 1 Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	301		MC301	I-103	Diversion Wet Well #2 Diversion Pump # 1 Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	301	A	YN301A	I-103	Diversion Wet Well #2 Diversion Pump # 1 VFD HOR in Remote Status	HOR Remote Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	YN	301	B	YN301B	I-103	Diversion Wet Well #2 Diversion Pump # 1 Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	
	SI	301		SI301	I-103	Diversion Wet Well #2 Diversion Pump # 1 Speed Feedback	VFD Speed Feedback	Diversion Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	301		SC301	I-103	Diversion Wet Well #2 Diversion Pump # 1 Speed Control	VFD Speed Control	Diversion Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	UA	301		UA301	I-103	Diversion Wet Well #2 Diversion Pump # 1 Surge Control Panel Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	From Local Surge Control Panel PIC-301
	MN	302		MN302	I-103	Diversion Wet Well #2 Diversion Pump # 2 Running Status	"M" Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	302		XA302	I-103	Diversion Wet Well #2 Diversion Pump # 2 Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	302		MC302	I-103	Diversion Wet Well #2 Diversion Pump # 2 Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	302	A	YN302A	I-103	Diversion Wet Well #2 Diversion Pump # 2 VFD HOR in Remote Status	HOR Remote Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	YN	302	B	YN302B	I-103	Diversion Wet Well #2 Diversion Pump # 2 Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	SI	302		SI302	I-103	Diversion Wet Well #2 Diversion Pump # 2 Speed Feedback	VFD Speed Feedback	Diversion Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	302		SC302	I-103	Diversion Wet Well #2 Diversion Pump # 2 Speed Control	VFD Speed Control	Diversion Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	UA	302		UA302	I-103	Diversion Wet Well #2 Diversion Pump # 2 Surge Control Panel Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	From Local Surge Control Panel PIC-302
	MN	303		MN303	I-103	Diversion Wet Well #2 Diversion Pump # 3 Running Status	"M" Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	303		XA303	I-103	Diversion Wet Well #2 Diversion Pump # 3 Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	303		MC303	I-103	Diversion Wet Well #2 Diversion Pump # 3 Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	303	A	YN303A	I-103	Diversion Wet Well #2 Diversion Pump # 1 VFD HOR In Remote Status	HOR Remote Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	YN	303	B	YN303B	I-103	Diversion Wet Well #2 Diversion Pump # 3 Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	
	SI	303		SI303	I-103	Diversion Wet Well #2 Diversion Pump # 3 Speed Feedback	VFD Speed Feedback	Diversion Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	303		SC303	I-103	Diversion Wet Well #2 Diversion Pump # 3 Speed Control	VFD Speed Control	Diversion Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	UA	303		UA303	I-103	Diversion Wet Well #2 Diversion Pump # 3 Surge Control Panel Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	From Local Surge Control Panel PIC-303
	MN	304		MN304	I-103	Diversion Wet Well #2 Drainage Pump Running Status	"M" Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	304		XA304	I-103	Diversion Wet Well #2 Drainage Pump Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	304		MC304	I-103	Diversion Wet Well #2 Drainage Pump Start/Stop Command	Motor Start/Stop	Diversion Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	304	A	YN304A	I-103	Diversion Wet Well #2 Drainage Pump VFD HOR in Remote Status	HOR Remote Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	YN	304	B	YN304B	I-103	Diversion Wet Well #2 Drainage Pump Local E-STOP Status	Local E-STOP Status	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	E-STOP							N	
	FI	310		FI310	I-103	Diversion Wet Well # 2 Discharge Flow	Magneter Flow Transmitter	Diversion Facility	AI	24V DC	SCADA	Y	No	SCADA			0	45	MGD	Absolute			Y	flow metering vault ?
	AI	310		AI310	I-103	Combustible Gas Detection - Methane - Diversion Wet Well #2	Combustible Gas Transmitter	Diversion Wet Well #2	AI	24V DC	SCADA	Y	No	SCADA			0	100	% LEL				Y	Gas Monitoring Panel
	XA	310		XA310	I-103	Combustible Gas Detection - Methane - Diversion Wet Well #2	Common Trouble Status Contact	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Gas Monitoring Panel
	AI	311		AI311	I-103	Hydrogen Sulfide Gas Detection - Diversion Wet Well #2	H2S Gas Detector Transmitter	Diversion Wet Well #2	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	Gas Monitoring Panel
	XA	311		XA311	I-103	Hydrogen Sulfide Gas Detection - Diversion Wet Well #2	Common Trouble Status Contact	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Gas Monitoring Panel

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Intrinsic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend Record	Notes
	AI	312		AI312	I-103	Combustible Gas Detection - Petroleum - Diversion Wet Well #2	Combustible Gas Transmitter	Diversion Wet Well #2	AI	24V DC	SCADA	Y	No	SCADA			0	100	% LEL				Y	Gas Monitoring Panel
	XA	312		XA312	I-103	Combustible Gas Detection - Petroleum - Diversion Wet Well #2	Common Trouble Status Contact	Diversion Wet Well #2	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Gas Monitoring Panel
	HSO	501		HSO501	I-104	Equalization Tank Motorized Isolation Valve - Open Command	Motorized Valve Actuator Open Command	Equalization Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	501		HSC501	I-104	Equalization Tank Motorized Isolation Valve - Closed Command	Motorized Valve Actuator Close Command	Equalization Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	501		ZIO501	I-104	Equalization Tank Motorized Isolation Valve - Open Position	Open Limit Switch	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							Y	
	ZIC	501		ZIC501	I-104	Equalization Tank Motorized Isolation Valve - Closed Position	Closed Limit Switch	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							Y	
	YN	501	A	YN501A	I-104	Equalization Tank Motorized Isolation Valve Local/Remote Status	Local/Remote Switch Status	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	~~HSO~~	~~502~~		~~HSO502~~	~~I-104~~	~~Diversion Flow to Equalization Motorized Isolation Valve - Open Command~~	~~Motorized Valve Actuator Open Command~~	~~Equalization Facility~~	~~DO~~	~~120 VAC~~	~~VALVE ACTUATOR~~	~~N~~	~~No~~	~~SCADA~~	~~Fully Open~~	~~Not Open~~							~~N~~	
	~~HSC~~	~~502~~		~~HSC502~~	~~I-104~~	~~Diversion Flow to Equalization Motorized Isolation Valve - Closed Command~~	~~Motorized Valve Actuator Close Command~~	~~Equalization Facility~~	~~DO~~	~~120 VAC~~	~~VALVE ACTUATOR~~	~~N~~	~~No~~	~~SCADA~~	~~Fully Closed~~	~~Not Closed~~							~~N~~	
	~~ZIO~~	~~502~~		~~ZIO502~~	~~I-104~~	~~Diversion Flow to Equalization Motorized Isolation Valve - Open Position~~	~~Open Limit Switch~~	~~Equalization Facility~~	~~DI~~	~~120 VAC~~	~~SCADA~~	~~N~~	~~No~~	~~SCADA~~	~~Fully Open~~	~~Not Open~~							~~Y~~	
	~~ZIC~~	~~502~~		~~ZIC502~~	~~I-104~~	~~Diversion Flow to Equalization Motorized Isolation Valve - Closed Position~~	~~Closed Limit Switch~~	~~Equalization Facility~~	~~DI~~	~~120 VAC~~	~~SCADA~~	~~N~~	~~No~~	~~SCADA~~	~~Fully Closed~~	~~Not Closed~~							~~Y~~	
	~~YN~~	~~502~~	~~A~~	~~YN502A~~	~~I-104~~	~~Diversion Flow to Equalization Motorized Isolation Valve Local/Remote Status~~	~~Local/Remote Switch Status~~	~~Equalization Facility~~	~~DI~~	~~120 VAC~~	~~SCADA~~	~~N~~	~~No~~	~~SCADA~~	~~Remote~~	~~Local~~							~~Y~~	~~from local control station~~
	LI	501		LI501	I-104	Equalization Tank Level	Radar Level Transmitter	Equalization Facility	AI	24V DC	SCADA	Y	N	SCADA			0	61	Feet	Absolute	5	57	Y	
	LAH	501		LAH501	I-104	Equalization Tank High Level	Capacitance High Level Switch	Equalization Tank Top	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	HIGH							Y	
	LAHH	501		LAHH501	I-104	Equalization Tank High High Level	Capacitance High High Level Switch	Equalization Tank Top	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	HIHI							Y	
	LAHH	502		LAHH502	I-104	Equalization Pipeline Junction Box High High Level	Float Level Switch	Flow Return Junction Box	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	HIHI							Y	
	MN	501		MN501	I-104	Equalization Tank Jet Mixing Pump # 1 Running Status	"M" Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	501		XA501	I-104	Equalization Tank Jet Mixing Pump # 1 Common Trouble Status	Common Trouble Status Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	501		MC501	I-104	Equalization Tank Jet Mixing Pump # 1 Start/Stop Command	Motor Start/Stop	Equalization Facility Electrical Building	DO	120 VAC	Motor Starter	N	No	SCADA	Start	Stop							N	
	YN	501		YN501	I-104	Equalization Tank Jet Mixing Pump # 1 Motor Starter HOR in Remote Status	HOR Remote Status	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	MN	502		MN502	I-104	Equalization Tank Jet Mixing Pump # 2 Running Status	"M" Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend Record	Notes
	XA	502		XA502	I-104	Equalization Tank Jet Mixing Pump # 2 Common Trouble Status	Common Trouble Status Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	502		MC502	I-104	Equalization Tank Jet Mixing Pump # 2 Start/Stop Command	Motor Start/Stop	Equalization Facility Electrical Building	DO	120 VAC	Motor Starter	N	No	SCADA	Start	Stop							N	
	YN	502		YN502	I-104	Equalization Tank Jet Mixing Pump # 2 Motor Starter HOR in Remote Status	HOR Remote Status	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	PAH	501		PAH501	I-104	Equalization Tank Jet Mixing Pump # 1 High Discharge Pressure	Diaphragm Actuated Pressure Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	N	SCADA	Normal	HIGH							Y	
	PAH	502		PAH502	I-104	Equalization Tank Jet Mixing Pump # 2 High Discharge Pressure	Diaphragm Actuated Pressure Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	N	SCADA	Normal	HIGH							Y	
	HSO	504		HSO504	I-104	Equalization Tank Jet Mixing Pump # 1 Drain Valve - Open Command	Motorized Valve Actuator Open Command	Jet Mixing Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	504		HSC504	I-104	Equalization Tank Jet Mixing Pump # 1 Drain Valve - Closed Command	Motorized Valve Actuator Close Command	Jet Mixing Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	504		ZIO504	I-104	Equalization Tank Jet Mixing Pump # 1 Drain Valve - Open Position	Open Limit Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	504		ZIC504	I-104	Equalization Tank Jet Mixing Pump # 1 Drain Valve - Closed Position	Closed Limit Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	504		YN504	I-104	Equalization Tank Jet Mixing Pump # 1 Drain Valve - Local/Remote Status	Local/Remote Switch Status	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	505		HSO505	I-104	Equalization Tank Jet Mixing Pump # 2 Drain Valve - Open Command	Motorized Valve Actuator Open Command	Jet Mixing Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	505		HSC505	I-104	Equalization Tank Jet Mixing Pump # 2 Drain Valve - Closed Command	Motorized Valve Actuator Close Command	Jet Mixing Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	505		ZIO505	I-104	Equalization Tank Jet Mixing Pump # 2 Drain Valve - Open Position	Open Limit Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	505		ZIC505	I-104	Equalization Tank Jet Mixing Pump # 2 Drain Valve - Closed Position	Closed Limit Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	505		YN505	I-104	Equalization Tank Jet Mixing Pump # 2 Drain Valve - Local/Remote Status	Local/Remote Switch Status	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	506		HSO506	I-104	Equalization Tank Jet Mixing Pump # 1 Discharge Isolation Valve - Open Command	Motorized Valve Actuator Open Command	Equalization Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	506		HSC506	I-104	Equalization Tank Jet Mixing Pump # 1 Discharge Isolation Valve - Closed Command	Motorized Valve Actuator Close Command	Equalization Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	506		ZIO506	I-104	Equalization Tank Jet Mixing Pump # 1 Discharge Isolation Valve - Open Position	Open Limit Switch	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	506		ZIC506	I-104	Equalization Tank Jet Mixing Pump # 1 Discharge Isolation Valve - Closed Position	Closed Limit Switch	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	506		YN506	I-104	Equalization Tank Jet Mixing Pump # 1 Discharge Isolation Valve - Local/Remote Status	Local/Remote Switch Status	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	507		HSO507	I-104	Equalization Tank Jet Mixing Pump # 2 Discharge Isolation Valve - Open Command	Motorized Valve Actuator Open Command	Equalization Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 — 6/24/2012 — 7/20/2012 — 8/27/2012 — 9/28/2012
Last Revision #: Preliminary — 90% Update — Additional Changes — Revised EQ Tank Design — Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinsic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	HSC	507		HSC507	I-104	Equalization Tank Jet Mixing Pump # 2 Discharge Isolation Valve - Closed Command	Motorized Valve Actuator Close Command	Equalization Facility	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	507		ZIO507	I-104	Equalization Tank Jet Mixing Pump # 2 Discharge Isolation Valve - Open Position	Open Limit Switch	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	507		ZIC507	I-104	Equalization Tank Jet Mixing Pump # 2 Discharge Isolation Valve - Closed Position	Closed Limit Switch	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	507		YN507	I-104	Equalization Tank Jet Mixing Pump # 2 Discharge Isolation Valve - Local/Remote Status	Local/Remote Switch Status	Equalization Facility	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	LAHH	503		LAHH503	I-104	Jet Mix Pump Station Washdown Sump High High Level	Float Level Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	Y	SCADA	Normal	HHH							Y	
	~~LAHH~~	~~504~~		~~LAHH504~~	~~I-104~~	~~Equalization Facility Valve Vault Sump High High Level~~	~~Float Level Switch~~	~~Equalization Valve Vault~~	~~DI~~	~~120 VAC~~	~~SCADA~~	~~N~~	~~Y~~	~~SCADA~~	~~Normal~~	~~HHH~~							~~Y~~	
	UA	599		UA599	I-104	Equalization Facility Electrical Building Fire Alarm System Common Trouble Status	Common Trouble Status Contact	Diversion Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Fire Alarm Panel
	~~FI~~	~~503~~		~~FI503~~	~~I-105~~	~~Equalized Wastewater Discharge Flow~~	~~Magneter Flow Transmitter~~	~~Equalization Valve Vault~~	~~AI~~	~~24V DC~~	~~SCADA~~	~~Y~~	~~No~~	~~SCADA~~			~~0~~	~~40~~	~~MGD~~	~~Absolute~~			~~Y~~	~~flow metering vault~~
	~~FC~~	~~503~~		~~FC503~~	~~I-105~~	~~Equalized Wastewater Flow Control~~	~~Motorized Modulating Valve Positioning Control~~	~~Equalization Valve Vault~~	~~AO~~	~~24V DC~~	~~SCADA~~	~~Y~~	~~No~~	~~SCADA~~			~~0~~	~~100~~	~~Percent~~				~~Y~~	
	~~ZI~~	~~503~~		~~ZI503~~	~~I-105~~	~~Equalized Wastewater Flow Control Valve Position Feedback~~	~~Motorized Modulating Valve Position Feedback~~	~~Equalization Valve Vault~~	~~AI~~	~~24V DC~~	~~SCADA~~	~~Y~~	~~No~~	~~SCADA~~			~~0~~	~~100~~	~~Percent~~				~~Y~~	
	~~YN~~	~~503~~	A	~~YN503A~~	~~I-105~~	~~Equalized Wastewater Flow Control Valve Local/Remote Status~~	~~Local/Remote Switch Status~~	~~Equalization Valve Vault~~	~~DI~~	~~120 VAC~~	~~SCADA~~	~~N~~	~~No~~	~~SCADA~~	~~Remote~~	~~Local~~							~~Y~~	~~from local control station~~
	FI	531		FI531	I-105	Equalized Flow Return Pump # 1 Discharge Flow	Magneter Flow Transmitter	Equalized Flow Return Pump Station	AI	24V DC	SCADA	Y	No	SCADA			0	7,000	GPM	Absolute			Y	
	FAL	531		FAL531	I-105	Equalized Flow Return Pump # 1 Seal Water Low Flow	Seal Water Rotameter Low Flow Switch	Equalized Flow Return Pump Station	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	Low							Y	contact from Pump VFD Cabinet
	MN	531		MN531	I-105	Equalized Flow Return Pump # 1 Running Status	"M" Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	531		XA531	I-105	Equalized Flow Return Pump # 1 Common Trouble Status	Common Trouble Status Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	531		MC531	I-105	Equalized Flow Return Pump # 1 Start/Stop Command	Motor Start/Stop	Equalization Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	531	A	YN531A	I-105	Equalized Flow Return Pump # 1 VFD HOR in Remote Status	HOR Remote Status	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	SI	531		SI531	I-105	Equalized Flow Return Pump # 1 Speed Feedback	VFD Speed Feedback	Equalization Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	531		SC531	I-105	Equalized Flow Return Pump # 1 Speed Control	VFD Speed Control	Equalization Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	FI	532		FI532	I-105	Equalized Flow Return Pump # 2 Discharge Flow	Magneter Flow Transmitter	Equalized Flow Return Pump Station	AI	24V DC	SCADA	Y	No	SCADA			0	7,000	GPM	Absolute			Y	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	FAL	532		FAL532	I-105	Equalized Flow Return Pump # 2 Seal Water Low Flow	Seal Water Rotameter Low Flow Switch	Equalized Flow Return Pump Station	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	Low							Y	contact from Pump VFD Cabinet
	MN	532		MN532	I-105	Equalized Flow Return Pump # 2 Running Status	"M" Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	532		XA532	I-105	Equalized Flow Return Pump # 2 Common Trouble Status	Common Trouble Status Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	532		MC532	I-105	Equalized Flow Return Pump # 2 Start/Stop Command	Motor Start/Stop	Equalization Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	532	A	YN532A	I-105	Equalized Flow Return Pump # 2 VFD HOR in Remote Status	HOR Remote Status	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	SI	532		SI532	I-105	Equalized Flow Return Pump # 2 Speed Feedback	VFD Speed Feedback	Equalization Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	532		SC532	I-105	Equalized Flow Return Pump # 2 Speed Control	VFD Speed Control	Equalization Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	FI	533		FI533	I-105	Equalized Flow Return Pump # 3' Discharge Flow	Magneter Flow Transmitter	Equalized Flow Return Pump Station	AI	24V DC	SCADA	Y	No	SCADA			0	7,000	GPM	Absolute			Y	
	FAL	533		FAL533	I-105	Equalized Flow Return Pump # 3 Seal Water Low Flow	Seal Water Rotameter Low Flow Switch	Equalized Flow Return Pump Station	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	Low							Y	contact from Pump VFD Cabinet
	MN	533		MN533	I-105	Equalized Flow Return Pump # 3 Running Status	"M" Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	533		XA533	I-105	Equalized Flow Return Pump # 1 Common Trouble Status	Common Trouble Status Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	533		MC533	I-105	Equalized Flow Return Pump # 3 Start/Stop Command	Motor Start/Stop	Equalization Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	533	A	YN533A	I-105	Equalized Flow Return Pump # 3 VFD HOR in Remote Status	HOR Remote Status	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	SI	533		SI533	I-105	Equalized Flow Return Pump # 3 Speed Feedback	VFD Speed Feedback	Equalization Facility Electrical Building	AI	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	SC	533		SC533	I-105	Equalized Flow Return Pump # 3 Speed Control	VFD Speed Control	Equalization Facility Electrical Building	AO	24V DC	VFD	N	No	SCADA			0	100	PCT				Y	
	HSO	531		HSO531	I-105	Equalized Flow Return Pump # 1 Drain Valve - Open Command	Motorized Valve Actuator Open Command	Equalization Flow Return Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	531		HSC531	I-105	Equalized Flow Return Pump # 1 Drain Valve - Closed Command	Motorized Valve Actuator Close Command	Equalization Flow Return Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	531		ZIO531	I-105	Equalized Flow Return Pump # 1 Drain Valve - Open Position	Open Limit Switch	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	531		ZIC531	I-105	Equalized Flow Return Pump # 1 Drain Valve - Closed Position	Closed Limit Switch	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	531		YN531	I-105	Equalized Flow Return Pump # 1 Drain Valve - Local/Remote Status	Local/Remote Switch Status	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	532		HSO532	I-105	Equalized Flow Return Pump # 2 Drain Valve - Open Command	Motorized Valve Actuator Open Command	Equalization Flow Return Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppresser	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Units	Alarms Type	Alarms Low	Alarms High	Trend Record	Notes
	HSC	532		HSC532	I-105	Equalized Flow Return Pump # 2 Drain Valve - Closed Command	Motorized Valve Actuator Close Command	Equalization Flow Return Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	532		ZIO532	I-105	Equalized Flow Return Pump # 2 Drain Valve - Open Position	Open Limit Switch	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	532		ZIC532	I-105	Equalized Flow Return Pump # 2 Drain Valve - Closed Position	Closed Limit Switch	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	532		YN532	I-105	Equalized Flow Return Pump # 2 Drain Valve - Local/Remote Status	Local/Remote Switch Status	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	533		HSO533	I-105	Equalized Flow Return Pump # 3 Drain Valve - Open Command	Motorized Valve Actuator Open Command	Equalization Flow Return Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	533		HSC533	I-105	Equalized Flow Return Pump # 3 Drain Valve - Closed Command	Motorized Valve Actuator Close Command	Equalization Flow Return Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	533		ZIO533	I-105	Equalized Flow Return Pump # 3 Drain Valve - Open Position	Open Limit Switch	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	533		ZIC533	I-105	Equalized Flow Return Pump # 3 Drain Valve - Closed Position	Closed Limit Switch	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	533		YN533	I-105	Equalized Flow Return Pump # 3 Drain Valve - Local/Remote Status	Local/Remote Switch Status	Equalization Flow Return Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	MN	534		MN534	I-105	Equalization Tank Drainage Pump # 1 Running Status	"M" Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	534		XA534	I-105	Equalization Tank Drainage Pump # 1 Common Trouble Status	Common Trouble Status Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	534		MC534	I-105	Equalization Tank Drainage Pump # 1 Start/Stop Command	Motor Start/Stop	Equalization Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	534	A	YN534	I-105	Equalization Tank Drainage Pump # 1 VFD HOR in Remote Status	HOR Remote Status	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	II	534		II534	I-105	Equalization Tank Drainage Pump # 1 Motor Current	MCC Motor Current Transmitter	Equalization Facility Electrical Building	AI	24V DC	MCC	N	No	SCADA			0	125	% FLC				Y	Trip Pump on low current after start
	MN	535		MN535	I-105	Equalization Tank Drainage Pump # 2 Running Status	"M" Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	
	XA	535		XA535	I-105	Equalization Tank Drainage Pump # 2 Common Trouble Status	Common Trouble Status Contact	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	
	MC	535		MC535	I-105	Equalization Tank Drainage Pump # 2 Start/Stop Command	Motor Start/Stop	Equalization Facility Electrical Building	DO	120 VAC	VFD	N	No	SCADA	Start	Stop							N	
	YN	535	A	YN535	I-105	Equalization Tank Drainage Pump # 2 VFD HOR in Remote Status	HOR Remote Status	Equalization Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	
	II	535		II535	I-105	Equalization Tank Drainage Pump # 2 Motor Current	MCC Motor Current Transmitter	Equalization Facility Electrical Building	AI	24V DC	MCC	N	No	SCADA			0	125	% FLC				Y	Trip Pump on low current after start
	MN	401		MN401	I-106	Diversion Wet Well Odor Control Fan Running Status	"M" Contact	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	Motor Start in Odor Control Panel
	XA	401		XA401	I-106	Diversion Wet Well Odor Control Fan Common Trouble Status	Common Trouble Status Contact	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Motor Start in Odor Control Panel
	MC	401		MC401	I-106	Diversion Wet Well Odor Control Fan Start/Stop Command	Motor Start/Stop	Facility Electrical Building	DO	120 VAC	RVSS	N	No	SCADA	Start	Stop							N	Motor Start in Odor Control Panel

Liddell Drive Equalization Facility - PLC I/O List

I&C Specification: 13120

Last Revised: 5/30/2012 6/24/2012 7/20/2012 8/27/2012 9/28/2012
Last Revision #: Preliminary 90% Update Additional Changes Revised EQ Tank Design Additional Changes

Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	YN	401		YN401	I-106	Diversion Wet Well Odor Control Fan Starter HOR in Remote Status	HOR Remote Status	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	Motor Start in Odor Control Panel
	UA	409		UA409	I-106	Diversion Wet Well Odor Control System Common Trouble Status	Common Trouble Status Contact	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Odor Control Panel
	AI	410		AIT410	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber Inlet	H2S Gas Transmitter	Diversion Facility Odor Control Scrubber OC-401	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	from Gas Monitoring Panel OCGMP-410
	XA	410		XA410	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber Inlet	Common Trouble Status Contact	Diversion Facility Odor Control Scrubber OC-401	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Gas Monitoring Panel OCGMP-410
	AI	411		AI411	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber	Combustible Gas Transmitter	Diversion Facility Odor Control Scrubber OC-401	AI	24V DC	SCADA	Y	No	SCADA			0	100	% LEL				Y	from Gas Monitoring Panel OCGMP-410
	AI	412		AI412	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber after Filter Bed	H2S Gas Transmitter	Diversion Facility Odor Control Scrubber OC-401	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	from Gas Monitoring Panel OCGMP-410
	XA	412		XA412	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber after Filter Bed	Common Trouble Status Contact	Diversion Facility Odor Control Scrubber OC-401	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Gas Monitoring Panel OCGMP-410
	AI	413		AI413	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber Outlet	H2S Gas Transmitter	Diversion Facility Odor Control Scrubber OC-401	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	from Gas Monitoring Panel OCGMP-410
	XA	413		XA413	I-106	Hydrogen Sulfide Gas Detection - Diversion Facility Odor Control Scrubber Outlet	Common Trouble Status Contact	Diversion Facility Odor Control Scrubber OC-401	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Gas Monitoring Panel OCGMP-410
	FAL	415		FAL415	I-106	Diversion Facility Valve Room Low Ventillation Air Flow	Thermal Air Flow Switch	Diversion Facility Electrical Building	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	Low							Y	contact output from Loss of Ventilation Alarming System
	MN	501		MN501	I-107	Equalization Facility Odor Control Fan Running Status	"M" Contact	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Running	Stopped							Y	Motor Start in Odor Control Panel
	XA	501		XA501	I-107	Equalization Facility Odor Control Fan Common Trouble Status	Common Trouble Status Contact	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	Motor Start in Odor Control Panel
	MC	501		MC501	I-107	Equalization Facility Odor Control Fan Start/Stop Command	Motor Start/Stop	Facility Electrical Building	DO	120 VAC	RVSS	N	No	SCADA	Start	Stop							N	Motor Start in Odor Control Panel
	YN	501		YN501	I-107	Equalization Facility Odor Control Fan Starter HOR in Remote Status	HOR Remote Status	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	In Remote	Local							N	Motor Start in Odor Control Panel
	UA	509		UA509	I-107	Equalization Facility Odor Control System Common Trouble Status	Common Trouble Status Contact	Facility Electrical Building	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Odor Control Panel
	AI	510		AI510	I-107	Hydrogen Sulfide Gas Detection - Equalization Facility Odor Control Scrubber Inlet	Combustible Gas Transmitter	Equalization Facility Odor Control Scrubber OC-501	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	from Gas Monitoring Panel OCGMP-510
	XA	510		XA510	I-107	Hydrogen Sulfide Gas Detection - Equalization Facility Odor Control Scrubber Inlet	Common Trouble Status Contact	Diversion Facility Odor Control Scrubber OC-401	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Gas Monitoring Panel OCGMP-510
	AI	511		AI511	I-107	Combustible Gas Detection - Methane - Equalization Facility Odor Control Scrubber	Combustible Gas Transmitter	Equalization Facility Odor Control Scrubber OC-501	AI	24V DC	SCADA	Y	No	SCADA			0	100	% LEL				Y	from Gas Monitoring Panel OCGMP-510

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Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	AI	512		AI512	I-107	Hydrogen Sulfide Gas Detection - Equalization Facility Odor Control Scrubber after Filter Bed	Combustible Gas Transmitter	Equalization Facility Odor Control Scrubber OC-501	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	from Gas Monitoring Panel OCGMP-510
	XA	512		XA512	I-107	Hydrogen Sulfide Gas Detection - Equalization Facility Odor Control Scrubber after Filter Bed	Common Trouble Status Contact	Diversion Facility Odor Control Scrubber OC-401	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Gas Monitoring Panel OCGMP-510
	AI	513		AI513	I-107	Hydrogen Sulfide Gas Detection - Equalization Facility Odor Control Scrubber Outlet	Combustible Gas Transmitter	Equalization Facility Odor Control Scrubber OC-501	AI	24V DC	SCADA	Y	No	SCADA			0	30	PPM				Y	from Gas Monitoring Panel OCGMP-510
	XA	513		XA513	I-107	Hydrogen Sulfide Gas Detection - Equalization Facility Odor Control Scrubber Outlet	Common Trouble Status Contact	Diversion Facility Odor Control Scrubber OC-401	DI	120 VAC	SCADA	N	No	SCADA	Normal	Trouble							Y	from Gas Monitoring Panel OCGMP-510
	FAL	515		FAL515	I-107	Equalization Facility Jet Mix Pump Room Low Ventilation Air Flow	Thermal Air Flow Switch	Equalization Facility Electrical Building	DI	120 VAC	SCADA	Y	Y	SCADA	Normal	Low							Y	contact output from Loss of Ventilation Alarming System
	FI	510		FI510	I-108	Equalization Tank Flushing Water Flow	Magneter Flow Transmitter	Jet Mixing Pump Station	AI	24V DC	SCADA	Y	No	SCADA			0	2000	GPM	Absolute			Y	
	HSO	511		HSO511	I-108	Equalization Tank Flushing Water Valve - Zone 1 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	511		HSC511	I-108	Equalization Tank Flushing Water Valve - Zone 1 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	511		ZIO511	I-108	Equalization Tank Flushing Water Valve - Zone 1 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	511		ZIC511	I-108	Equalization Tank Flushing Water Valve - Zone 1 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	511		YN511	I-108	Equalization Tank Flushing Water Valve - Zone 1 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	512		HSO512	I-108	Equalization Tank Flushing Water Valve - Zone 2 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	512		HSC512	I-108	Equalization Tank Flushing Water Valve - Zone 2 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	512		ZIO512	I-108	Equalization Tank Flushing Water Valve - Zone 2 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	512		ZIC512	I-108	Equalization Tank Flushing Water Valve - Zone 2 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	512		YN512	I-108	Equalization Tank Flushing Water Valve - Zone 2 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	513		HSO513	I-108	Equalization Tank Flushing Water Valve - Zone 3 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	513		HSC513	I-108	Equalization Tank Flushing Water Valve - Zone 3 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	513		ZIO513	I-108	Equalization Tank Flushing Water Valve - Zone 3 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	513		ZIC513	I-108	Equalization Tank Flushing Water Valve - Zone 3 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	513		YN513	I-108	Equalization Tank Flushing Water Valve - Zone 3 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	514		HSO514	I-108	Equalization Tank Flushing Water Valve - Zone 4 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	

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I&C Specification: 13120

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Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend Record	Notes
	HSC	514		HSC514	I-108	Equalization Tank Flushing Water Valve - Zone 4 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	514		ZIO514	I-108	Equalization Tank Flushing Water Valve - Zone 4 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	514		ZIC514	I-108	Equalization Tank Flushing Water Valve - Zone 4 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	514		YN514	I-108	Equalization Tank Flushing Water Valve - Zone 4 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	515		HSO515	I-108	Equalization Tank Flushing Water Valve - Zone 5 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	515		HSC515	I-108	Equalization Tank Flushing Water Valve - Zone 5 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	515		ZIO515	I-108	Equalization Tank Flushing Water Valve - Zone 5 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	515		ZIC515	I-108	Equalization Tank Flushing Water Valve - Zone 5 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	515		YN515	I-108	Equalization Tank Flushing Water Valve - Zone 5 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	516		HSO516	I-108	Equalization Tank Flushing Water Valve - Zone 6 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	516		HSC516	I-108	Equalization Tank Flushing Water Valve - Zone 6 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	516		ZIO516	I-108	Equalization Tank Flushing Water Valve - Zone 6 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	516		ZIC516	I-108	Equalization Tank Flushing Water Valve - Zone 6 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	516		YN516	I-108	Equalization Tank Flushing Water Valve - Zone 6 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	517		HSO517	I-108	Equalization Tank Flushing Water Valve - Zone 7 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	517		HSC517	I-108	Equalization Tank Flushing Water Valve - Zone 7 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	517		ZIO517	I-108	Equalization Tank Flushing Water Valve - Zone 7 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	517		ZIC517	I-108	Equalization Tank Flushing Water Valve - Zone 7 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	517		YN517	I-108	Equalization Tank Flushing Water Valve - Zone 7 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	518		HSO518	I-108	Equalization Tank Flushing Water Valve - Zone 8 - Open Command	Motorized Valve Actuator Open Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	518		HSC518	I-108	Equalization Tank Flushing Water Valve - Zone 8 - Closed Command	Motorized Valve Actuator Close Command	Equalization Tank	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	
	ZIO	518		ZIO518	I-108	Equalization Tank Flushing Water Valve - Zone 8 - Open Position	Open Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	518		ZIC518	I-108	Equalization Tank Flushing Water Valve - Zone 8 - Closed Position	Closed Limit Switch	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	518		YN518	I-108	Equalization Tank Flushing Water Valve - Zone 8 - Local/Remote Status	Local/Remote Switch Status	Equalization Tank	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station
	HSO	519		HSO519	I-108	Equalization Tank Flushing Water Isolation Valve - Open Command	Motorized Valve Actuator Open Command	Jet Mixing Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Open	Not Open							N	
	HSC	519		HSC519	I-108	Equalization Tank Flushing Water Isolation Valve - Closed Command	Motorized Valve Actuator Close Command	Jet Mixing Pump Station	DO	120 VAC	VALVE ACTUATOR	N	No	SCADA	Fully Closed	Not Closed							N	

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Process Area	ISA Tag	Loop Number	Suffix	Full Tag Number	P & ID	Service Description	Instrument Description	Physical Location	I/O Type	I/O Voltage	I/O Power Source	Surge Suppressor	Instrinic Safety	Display	One State	Zero State	Display Low Range	Display High Range	Display Units	Alarms Type	Alarms Low	Alarms High	Trend / Record	Notes
	ZIO	519		ZIO519	I-108	Equalization Tank Flushing Water Isolation Valve - Open Position	Open Limit Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Open	Not Open							N	
	ZIC	519		ZIC519	I-108	Equalization Tank Flushing Water Isolation Valve - Closed Position	Closed Limit Switch	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Fully Closed	Not Closed							N	
	YN	519		YN519	I-108	Equalization Tank Flushing Water Isolation Valve - Local/Remote Status	Local/Remote Switch Status	Jet Mixing Pump Station	DI	120 VAC	SCADA	N	No	SCADA	Remote	Local							Y	from local control station

SECTION 13150
INSTRUMENTATION AND CONTROLS – LOGIC DESCRIPTIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section contains written descriptions of control logic and control strategies provided as a guide to facilitate detailed design, configuration, implementation, and start-up of the Plant Control System. This information is provided as a supplement to other information provided by the Contract Drawings including the P&I Ds (Piping and Instrumentation Drawings). The intent of this section is not to define every detail or nuance of the Control System design but to provide general guidelines for estimating the engineering, check-out, and start-up time anticipated to be spent to complete the software configuration associated for providing the Plant Control System.

B. Control Strategies and logic presented in this section will require further refinement and coordination with the Contractor and/or Owner to achieve a fully integrated and fully functional control system design.

C. Work associated with this section may be performed by one or more parties including the Owner. This section does not attempt to apportion work or responsibility for work among the various sub-contractors, suppliers, and manufacturers.

PART 2 - PRODUCTS

2.01 GENERAL CONFIGURATION REQUIREMENTS

A. Graphics Configuration Standards

1. To minimize the training of the plant operators for the Liddell Drive Equalization Facility, the Plant Control System Graphics shall be designed to be compatible with the existing City of Atlanta graphics standards.

2. A complete set of Graphical displays to cover all existing and new process areas connected to the Plant Control System shall be provided. Each Operator Console shall be loaded with a complete hierarchical sequence of displays including Overview Graphic(s), Individual Process Graphics, Trend Displays, SCADA System Maintenance Graphics, Text Information Pages (Elapsed Motor Run Times, for instance), and Alarm Summary Pages.

B. Discrete Input Monitoring and Alarming

1. All Discrete Inputs shown on the P&IDs and/or Instrument Index/ I/O List shall be included in the system database of the Plant SCADA system and shall have their status shown on the appropriate plant graphic (s). Logic state descriptors shall be initially set to the values shown in the I/O list. Where indicated in the I/O List, discrete inputs shall be enabled for audible alarming. Where indicated in the I/O List, discrete inputs shall be included in the trend points database.

2. Graphics color conventions shall be established to denote when a point is in normal non-alarmed mode, alarm unacknowledged alarm mode, or alarm acknowledge alarm mode.

C. Analog Input Monitoring and Alarming

1. All Analog Inputs shown on the P&IDs and/or Instrument Index/ I/O List shall be included in the system database of the Plant SCADA system and shall have their status shown on the appropriate plant graphic (s). High and Low Alarm limits shall be initially set to the values shown in the I/O list. Where indicated in the I/O List, analog inputs shall be included in the trend points database.

2. Graphics color conventions shall be established to denote when a point is in normal non-alarmed mode, alarm unacknowledged alarm mode, alarm acknowledge alarm mode or measurement out of range (high or low).

D. Generic Motor Control Conventions

1. All motor controls shown on the P&IDs and/or Instrument Index/ I/O List shall be included in the system database of the Plant SCADA system and shall have their status shown on the appropriate plant graphic (s). Where the Plant Control System has any automatic sequencing type control of motor operation, Hand-OFF-Auto type selector switches shall be provided on the plant graphics to allow automatic interlocks to be bypassed. In Hand mode, the automatic software interlocks shall be bypassed and the motor run continuously except that any hardwired motor starter type interlocks shall still be enabled to protect equipment or operations. In the OFF mode, the motor shall be stopped. In the Auto position, operation of the motor shall be dependent on the associated automatic logic configured for that piece of equipment.

2. Graphics color conventions shall be established to denote when a motor is stopped normally, failed to start, or running (different colors for two speed motors running in slow or fast speeds). Status of software H-O-A Switches associated with each motor shall be clearly visible on each graphics. Associated status of trouble inputs or other status information for each motor shall be displayed as well in proximity to each motor/equipment symbol.

E. Priority of Local verses Remote Controls: The plant operating philosophy will be that local controls take precedence over remote controls in a hierarchical order. Local E-STOP pushbuttons shall disable any and all inputs to Control Panels, Motor Starters, or Variable Frequency Drives (VFD) to disable pump/fan/motor operation for as long as the E-STOP pushbutton is depressed – motor operation will be interrupted and will not automatically restart until motor start is reinitiated by the plant operators. Similarly local Hand-Off-Remote (Auto) type selector switches when in the OFF position shall disable motor operation and must be manually reinitiated. Local H-O-R(A) Selector Switches when in the HAND position shall enable the motor for operation regardless of the intended automatic operating mode for that motor. Hardwired Interlocks shall remain enabled to disable motor operation for equipment and/or operator protection. When the Local H-O-R(A) Selector switch is in the Remote (Auto) Position, operating control is passed to the associated Control Panel or Motor Starter/VFD. When there is a Control panel or Motor Starter/VFD H-O-R(A) type selector switch it shall similarly override the control of the Plant Control System as long as any local controls are in the Remote position. Only when both the local and Control Panel/Starter/VFD H-O-R(A) Selector Switches are in the Remote Position is the Plant Control System in complete control of the associated motor. There will be a Plant Control System status indication that the H-O-R switch on the Control Panel/Starter/VFD is in "Auto/Remote" allowing Plant Control System control of the motor.

F. Motor Elapsed Run Timers: All process motors that the Plant Control System monitors the running status of will be configured to accumulate elapsed run time to be displayed on a

consolidated run time status graphic. The run time accumulators shall be configured to be able to be commonly reset by a common run time reset pushbutton that might later to be reconfigured to reset on some other automatic basis.

2.02 LIDELLL DRIVE EQUALIZATION OPERATING STRATEGY

A. General Plant Operating Strategy:

1. The Liddell Drive Equalization project will be designed to be able to be run in a fully automated standalone local operation mode. The facility will be designed to not require an on-site operations staff. Operators will be required to visit the site periodically for visual inspections, periodic cleaning and other maintenance purposes. The control system will be designed for local operation but will have remote monitoring for selected operating conditions and limited override capability for pumping equipment at the RM Clayton or an alternate City of Atlanta (CoA) facility.

2. Normal operation of the Equalization Facility will be standby – offline mode. Only on a rain event when the flow thru the South Fork Peachtree Creek sanitary sewer trunk line exceeds a set amount of flow (initial set at 24 MGD) or the level in the sanitary sewer at the Peachtree Creek Trunk Relief Sewer Level Monitoring Manhole exceeds a set level or as determined by the Operations at the RM Clayton WRC will the sanitary sewer flow be diverted to the Equalization Tank for short term short (from a few hours up to 3 days) storage of the excess/peak wastewater flow that would otherwise would contribute to increased peak flows at the RM Clayton WRC.

3. When the rain event has passed, the wastewater stored in the Equalization Tank will be pumped to the Cheshire Bridge Junction Box, then flow by gravity to the South Forks Peachtree Creek Trunk sewer to continue to flow by gravity to the RM Clayton WRC. Total Flow in the Sanitary Sewer and Downstream Level at the existing Peachtree Creek Trunk Relief Sewer Level Monitoring Manhole will be monitoring during the gravity return operation to limit surging. Operation of the gravity return of wastewater from the Equalization Tank shall operate to slowly drain down the wastewater in the Tank in automatic manner in keeping with the Peachtree Creek Trunk Relief Manhole level and total sanitary sewer flow limits established by plant operations.

B. Remote Monitoring and Control Requirements: Remote monitoring and control features proposed include the following:

1. Remote Monitoring
   a. Peachtree Creek Trunk Relief Manhole (PCTRM) Level
   b. Sanitary sewer flow rate
   c. Diversion Wet Well levels
   d. Diversion Pump Discharge Flow rates
   e. Equalization Tank level
   f. Equalization Flow Return Pumps Discharge flow rate
   g. Equipment status – auto/run/fault
   h. Motorized Sluice Gate and Valve status – open/close/remote enable
   i. Relief Event Active

2. Remote Control
   a. Prohibit Equalization Tank emptying
   b. Initiate (or Inhibit) Sanitary Sewer diversion to Diversion Wet Wells
   c. Selection of Lead/Lag Diversion Structures and Wet Wells
   d. Individual submersible pump start/stop
   e. Sewage Grinder start/stop
   f. Motorized Sluice Gate control (open/close)
   g. Motorized isolate valve control (open/close)
   h. Jet Mix Pumps start/stop
   i. Flow Control of the return of Equalized Wastewater thru the Flow Return and individual pump start.stop
   j. Individual EQ Tank Drainage pump start/stop
   k. Initiate or manually control Equalization Tank Flushing
3. The following main control devices are provided:
   a. Diversion Structure #1 Sluice Gates SLG-101-1, 101-2, 101-3 (Open/Close with status) and Diversion Structure #2 Sluice Gates SLG-102-1, 102-2, 102-3 (Open/Close with status)
   b. Diversion Wet Well #1 Isolation Sluice Gates SLG-201 and 202 (Open/Close with status). Diversion Wet Well Interconnection Sluice Gate SLG-203 (Open/Close with status)
   c. Redundant Radar Level transmitter LIT-201 and LIT-202 at Diversion Wet Well # 1and hardwired level level float switches LSL-203 (stops Diversion Pumps P-201, 202, and 203s) and LSL-204 (stops drainage Pump P-204)
   d. Flow transmitter (Magmeter) FIT-210 on outlet of Diversion Pumps P-201, 202, and 203
   e. Diversion Wet Well #2 Isolation Sluice Gates SLG-301 and 302 (Open/Close with status)
   f. Redundant Radar Level transmitter LIT-301 and LIT-302 at Diversion Wet Well # 2and hardwired level level float switches LSL-303 (stops Diversion Pumps P-301, 302, and 303) and LSL-304 (stops drainage Pump P-304)
   g. Flow transmitter (Magmeter) FIT-310 on outlet of Diversion Pumps P-301, 302, and 303
   h. Open/Close Motorized Valves FCV-203 (Isolation of diversion flow from returning to Sanitary Sewer), and FCV-501 (Equalization Tank Isolation ValveRadar Level Transmitter LIT-501 on top of the Equalization Tank and Capacitance High and High High Level Switches LSH-501 and LSHH-501 on the top of the Equalization Tank
   i. Cheshire Bridge Junction Chamber High High Level Switch LSHH-502
   j. Open/Close Motorized Valves FCV-506/507 (Jet Mixing Pumps Discharge Isolation valves)
   k. Open/Close Motorized Valve FCV-504/505 (Jet Mix system back flushing valves)
   l. Open/Close Motorized Valve FCV-531/532/533 (Drain valves for Flow Return pumps P-531/532/533)
   m. Redundant Flow transmitter (Marsh McBirney Flo Dar) FIT-110A and FIT-110B downstream of the two diversion structures

n. Redundant Ultrasonic Level transmitters LIT-120A and LIT-120B at Peachtree Creek Trunk Relief Manhole (PCTRM) MH 23180203601.

o. Equalization Tank Flushing Water flow transmitter (magmeter) FIT-510

p. Equalization Tank Flushing Water Motorized Valves FCV-511 thru FCV-518.

q. Flow Transmitters (Magmeters) FIT-531/532/533 on the outlet of the Equalized Flow Return Pumps

r. H2S and Combustible Gas Monitors AIT-410/411/412/413 at the Diversion Facility odor control system

s. H2S and Combustible Gas Monitors AIT-510/511/512/513 at the Equalization Facility odor control system

C. Pump Station Operating Modes: There will be essentially three modes of operation for the facility as follows:

1. Dry Weather Operation – Equalization Facility is bypassed, equipment operating in Maintenance Mode to empty wet well drainage and maintain pumps. During Wet Weather Operations when a Relief is Event is Inactive due to Equalization Tank being full or Diversion is inhibited for any other reason, the Facility will enter its Dry Weather Maintenance Operating Mode.

2. Wet Weather Operation/Relief Event Active – – Diversion Pump stations are operating transferring flow to the equalization tank. Equalization Tank is in service. Wet Weather Operations being defined as flows in the South Peachtree Creek Trunk Sewer above normal operating levels. Such sewer flows and high pipeline levels are typical of sewer operation during the periods of stormy, rainy weather in the Atlanta area where the influent flow to RM Clayton WRC greatly exceeds the normal diurnal flow to the wastewater treatment plant. During such wet weather operation, Relief of excess sewer flow will be diverted to be stored in the Equalization Tank if tank capacity and equipment operations permit such Relief event to be active.

3. Dry Weather Flow/Equalized Flow Return Mode – Return flow to Sanitary Sewer system to empty the equalization tank. When flow rates in the South Peachtree Creek Trunk sewer drops below its Wet Weather operating limits, RM Clayton Plant operations can permit the wastewater temporarily stored in the Equalization tank to be slowly pumped back into the sewer system to ready the EQ facility to be ready to intercept future peak sewer flows.

D. Dry Weather Operations

1. Standby Operation: During normal operating/dry weather conditions (i.e., less than 24 MGD of flow) the sewage flow in the sanitary sewer system will flow through the two diversion structures and continue to flow in the South Forks Relief sewer without any flow being diverted to the Equalization Facility.

2. Dry Weather Operations Controls: The following systems are in operation in dry weather standby mode:
   a. Level is monitored at the Peachtree Creek Trunk Relief Manhole (PCTRM) (LIT-120A and LIT-120B)
   b. Sanitary sewage flow monitored downstream of the Diversion Structures by FIT-110A and FIT-110B.
   c. Wet well drainage pumps (P-204 and P-304) are operational to pump drainage or seepage out of the wet wells.

d. Wet Well Diversion Pumps, sludge grinders and other systems are in Maintenance Mode

3. Diversion Structure Sluice Gate Control: During dry weather flow, the diversion structure sluice gates are all closed so no flow enters the diversion pump station except minor gate leakage. If any gate is not closed and a relief event is not in progress, a gate position alarm will be initiated.

E. Diversion Wet Well Drainage Pumps: During dry weather conditions, the diversion wet well drainage pumps (P-204 and P-304) will operate in a start/stop mode based on level. The pumps will discharge flow back into the Peachtree Creek Relief Sewer. When the wet well level rises to the start level, the associated pump will start and run until the wet well level drops to the low/pump stop level at which point the pump will stop. If the water level continues to rise above the pump start level to the high level set point, an alarm will be activated indicating excessive dry weather flow into the pump station or a pump blockage.

1. A separate low level switch in each Wet Well is provided to stop the drainage pumps on an abnormally low water level.

F. Dry Weather Maintenance Mode

1. Dry Weather Maintenance Operation: Maintenance Mode is provided to periodically exercise equipment during extended periods of inactivity to ensure pumps are maintained in operational condition and do not sit stationary for an extended period of time. In Maintenance Mode, the wet well diversion pumps, wet well odor control fan (F-401), sewage grinders, Jetmixing pumps, equalized flow return pumps, equalization tank drainage pumps, and all other pieces of non-operational motorized equipment will be "bumped" periodically to rotate the equipment if it has not operated in a relief event for more than an adjustable number of days (initially set at 14 days). Each pump, fan or grinder will be started and run for a short adjustable period (that will be established by the equipment manufacturer). A different time will be allowed for each type or size of equipment and the control system will sequence each piece of equipment such that they do not start and stop simultaneously. After a piece of equipment has operated for any reason, the Maintenance Mode timer for that piece of equipment will reset. Pumps will be operated at minimum speed during maintenance mode. Level and flow interlocks must be bypassed during this mode.

2. Indication of dry weather maintenance mode: A maintenance mode indication will be indicated when maintenance mode is active. If a relief event is initiated during maintenance mode, maintenance mode will be interrupted and the relief sequence activated.

G. Wet Weather Operations (Relief Event Active)

1. Initiating Wet Weather Operating Mode: Wet weather operating mode will be active whenever a relief event is triggered. The control system will be designed with flexibility for control and set points. Over time, as operational information and feedback on flow rates and sewer levels is developed, adjustments to the control strategy and set points may be beneficial as the response to the system from relief and flow return is recorded. Ideally the controls will divert the minimum flow rate possible to prevent system surcharges and overflow events. The initial setpoints should be conservative to ensure that these conditions are met at the facility start-up, but can be adjusted if required in the future.

2. A relief event can be triggered by the following conditions:
   a. High water level at the Peachtree Creek Trunk Relief Manhole (PCTRM) MH 23180203601 (LIT-120A and LIT-120B. If a flow diversion is initiated from high level being measured at the remote level monitoring manhole – the entire flow from the South Fork Peachtree Creek Trunk and Relief Line will be diverted. Entire diversion up to the design flow of 67 MGD is required since there is no flow information currently available to generate a flow diversion rate set point. This will be the level control mode. In the future, if/when flow data is available, this control could switch to flow control mode.
   b. High flow rate at the Flow Metering Structure (FIT-110A and FIT-110B) at SFPC site downstream of the two diversion structures is greater than an adjustable flow rate (initially set at 24 MGD) initiates flow control mode.
   c. Alternate trigger point from CoA facility or remote monitoring location.
   d. Manually initiated on the pump station graphics on the local control panel.
   e. Based on conditions within the Peachtree Creek sewer system, the permissible flow set point can be adjusted automatically by external input. There will be an initial set point that is used to initiate diversion based on the South Fork Peachtree Creek sewage flow at FE-110. However, if the diversion is triggered by an alternate input from somewhere else in the system such as the PCTRM, the permissible flow can be set to a lower flow rate that could be as low as 0, requiring diversion of all flow from the South Fork relief sewer.
   f. During a relief event the total sanitary sewer flow rate will be calculated and recorded by the control system by summing flow meters FE-110, FE-210 and FE-310.
3. Diversion Structure Sluice Gate Controls
   a. There are two diversion structures, DS-101 and DS-102 each with three sluice gates. The diversion structures control the diversion of sanitary sewage into the Diversion Pump Station. Each diversion structure can be set as lead or lag by the operator. Typically DS-101 will be the lead diversion structure. Within each diversion structure there are three sluice gates that can be set as lead, lag1, or lag2 by the operator. When a wet weather relief event is initiated by one of the above conditions, the lead slide gate will open allowing some flow to be diverted to the pump station. The opening time for the gates will be adjustable to control the initial diversion rates to the pump station. Once the lead slide gate is open, the lag1 sluice gate will open. Then when the lag1 sluice gate is open, the lag2 sluice gate will open. The gates will remain open until the relief event has ended or the equalization tanks are full..
   b. Operation of the lag diversion structure will be initiated by the diversion pump station controls as described below. Once the lag diversion structure operation is initiated, operation will be identical to the lead diversion structure operation.
4. Diversion Pump Station Controls
   a. When a relief event is initiated, the diversion pump station operation will switch from Maintenance Mode to Wet Weather Relief Active Mode
   b. When a relief event is triggered and a diversion structure becomes active, the diverted flow will enter the respective diversion pump station wet well. Two wet wells are provided at the pump station that operate independently of one other. Each wet well is dedicated to a specific diversion structure. There is an interconnection gate between the two wet wells for flexibility and for operation when there can be equipment out of service. The operation of each diversion pump station wet well is identical.

c. Each wet well is provided with two inlet sluice gates (SLG-201, SLG-202, SLG-301 and SLG-302) for maintenance isolation. Each gate is installed upstream of a sewage grinder and can be used to isolate the respective grinder or the entire wet well if both gates are closed. The gates are normally in the open position when a Relief Event is active. The gates can be operated either locally or remotely. If any gate is closed when the associated Diversion Chamber is called to operate, the gates will be opened at or before the time the lead sluice gate in the associated diversion structure is instructed to open.

d. Each wet well is provided with two wastewater grinders (WWG-201, WWG-202, WWG-301 and WWG-302). Each grinder is provided with a local control panel that controls grinder operations although normally they will be switched for remote control (start/stop) and status monitoring from the plant control system. The grinders will start at the same time as the lead sluice gate in the associated diversion structure is instructed to open. The grinders will operate continuously once they are started and will be shut down when the last diversion pump in the wet well stops.

e. A total of six diversion pumps are provided in the pump station, three in each wet well (P-201, P-202, P-203 and P-301, P-302, P-303). Five pumps are duty pumps and one is a standby. All pumps will be configured for operation; the standby pump will simply not be required for operation to meet process conditions. The pumps in each wet well will be configured as lead, lag1, lag2. The pump wet wells will also operate as lead / lag. The lead wet well will be the one associated with the lead diversion structure.

f. The flow rate into the diversion pump station and the required diversion flow rate will vary continuously during operations. Under some conditions, the diversion flow rate into the pump station will exceed the required diversion flow rate and under other conditions the flow rate into the wet well will be less than the required diversion flow rate. When the flow into the wet well exceeds the required diversion flow rate, the wet well level will fill to the level in the sanitary sewer and the flow rate will be controlled by the pumping system to match the required diversion flow rate. When the flow into the wet well is less than the diversion flow rate, the wet well will be pumped down to a low level and the flow rate will be controlled by the pumping system to match the maximum diversion flow rate possible at that time.

g. To accommodate the varying conditions there will be two modes of control, flow and level. In flow control mode, the pump operation will be controlled by the flow rate as measured at FE-110. The pump operation will be controlled to pump all flow above the permissible flow set point to the equalization tanks. In level control mode, the pumps will operate to maintain the set wet well level. If the required flow set point is "0", the pumps will operate in level control mode and pump all flow possible up to the pump station capacity. The two wet wells can operate in different modes to suit the current flow requirements. So one wet well can be in flow control and one in level control, both in flow control or both in level control.

h. Each of the diversion pumps is provided with a variable frequency drive to control the pump speed and flow rate. There is also a minimum pumping rate/pump speed that must be maintained for satisfactory pump operations.

i. Level control mode will be used whenever the Wet Weather Relief mode is initiated by high level at the remote level monitoring manhole (LI-120) or when flow control mode set point is not available for another reason. In this mode, there will be a target level set point in each wet well and the pumps will be started, stopped and speed controlled to

maintain the target level within an acceptable band above/below the target set point. Pumps must be started and stopped such that the flow rate from each wet well is maintained within the limits stated below to ensure proper pump operation.

j. In flow control mode, the pumps will be started, stopped and speed controlled to achieve the target flow rate. Pumps must be started and stopped such that the flow rate from each wet well is maintained within the limits stated below to ensure proper pump operation.

k. When a diversion event starts and the first pump is started, the pipeline to the equalization tank will be empty so there will be no outlet pressure on the pump so an artificial pressure control device is necessary to ensure proper pump operation. The magnetic flow meters will also be empty, so the flow signal must be ignored for an adequate time until the pipeline is filled.

l. The magmeter will become active and control switched to flow control mode after the diversion pump(s) have operated for a long enough period to fill the discharge piping and flow meters. If a single diversion pump is operating, this start-up filling time will be 16 minutes. If two diversion pumps are operating, start-up filling time will be 8 minutes. If more than two pumps are operating, this start-up filling time will be 6 minutes. These pre-set timer valves will be operator adjustable.

m. During start-up/pipeline filling mode, the pumps will be operated at minimum speed and the discharge pressure will be controlled by the pump control valves PCV-201/202/203 and PCV-301/302/303. The pressure set point (initially set at 8 psi) and pump speed (initially set at 30 Hz) will be set such that the nominal flow rate during start-up will be approximately 10.0 MGD.

n. There will be an adjustable time delay between pump starts to establish pump operation and minimize pressure surges during start-up and shutdown.

o. Pump start will be different depending on whether the pipeline is full or not. When the pipeline is empty – pipeline filling time not reached, the pump start will be as follows:

   i) When the pump starts, the associated pump control valve PCV-201/202/203 and PCV-301/302/303 will be closed. The pump will start and ramp up to the minimum speed set point.

   ii) As soon as the upstream pressure (pump outlet Pressure) reaches 10 psi, the valve will open to maintain the 10 psi pump discharge pressure.

   iii) The valve will open and throttle as required to maintain the 10 psi pump discharge pressure – pressure on outlet side is less than 8 psi.

   iv) When the valve opens and upstream pressure remains above 8psi, the valve will fully open.

   v) Each pump will start in this manner following the time delay until the required number of pumps are in operation.

p. Pump start after the pipeline filling time has been reached will be as follows:

   i) When the pump starts, the associated pump control valve PCV-201/202/203 and PCV-301/302/303 will be closed. The pump will start and ramp up to the speed of the other operating pumps. The pump control valve will slowly open and open continuously until the valve is fully open.

   ii) The pump speed will then be adjusted in conjunction with the other operating pumps to meet the control set point.

iii) When pumps are operating in level or flow control mode, the pumps must operate within a confined range depending on the number of pumps in operation. The control set points will be adjustable and initially set as:

Number Of Pumps In Operation In The Respective Wet Well	Minimum Acceptable Flow	Maximum Acceptable Flow
1	7 mgd	14 mgd
2	12.5 mgd	28 mgd
3	25 mgd	42 mgd

iv) Pumps will be started and stopped to maintain operation within these limits..

q. Pump Stop Operation. When a pump is called to stop under normal operation the pump shutdown operation shall be as follows:

i) Pump stop signal is activated; the associated pump control valve begins to close.

ii) When the valve closes to an adjustable set point, the pump will be stopped.

iii) The valve will continue closing until fully closed.

r. Loss of Power Operation. When power is lost for any reason during operation, the pump control valve will automatically close without external power under a controlled rate to prevent slamming and reverse flow.

s. The lag diversion structure and associated wet well will be called to operate whenever either of the following conditions occurs:

i) The wet well level in the lead wet well drops to the level control set point and the flow rate at flow metering structure (FE/FIT-110A/B) still exceeds the permissibleflow rate. This will occur if the flow rate from the diversion structure is not adequate to meet the diversion flow rate required.

ii) All available pumps in the lead wet well are called to operate and reach full speed (or maximum allowable speed) and the permissible flow rate cannot be maintained at flow metering structure (FE/FIT-110A/B). This will occur if the required diversion flow rate exceeds the capacity of the available pumps in the lead wet well.

t. When the relief event has ended, the pump station will return to Dry Weather Maintenance Mode.

u. Open/Close Isolation Valve FCV-203 will be used to determine whether the flow from the Diversion Pump Stations will be returned to the South Forks Peachtree Creek Relief Sewer or diverted to the Equalization Tank. Normally it will be closed whenever a relief event is in progress and any diversion pump is in operation.

v. A separate low level switch in each Wet Well will be provided to initiate an alarm and stop the associated Diversion pumps in each Wet Well if an abnormally low water level is detected. The pumps will alternate lead/lag1/lag2 status after each operating cycle.

w. Pumps shall have thermal sensors to monitor motor stator temperatures. Thermal sensors shall be placed in each motor winding. Moisture sensors shall be provided in the seal chambers and/or motor housing to protect the gear and motor from moisture. Pump motor protection monitoring shall be as required by the submersible pump manufacturer. The motor protection system shall disable each individual pump when an abnormal operating condition has been detected. This will result in a high priority alarm being generated and the next pump in the operating sequence shall be started.

x. Process alarms will be indicated for any of the following condition:

i) Permissible flow rate at flow metering structure (FE/FIT-110A/B) exceeds the set point for a minimum adjustable period of time. A time delay is provided to allow time for start-up and speed adjustment of the pumping system.

ii) Permissible flow rate at flow metering structure (FE/FIT-110A/B) is less than the set point for a minimum adjustable period of time. A time delay is provided to allow time for start-up and speed adjustment of the pumping system.

5. Wet Well Drainage Pumps: After a relief event has ended, the diversion pumps have stopped, and the flow return conditions described below have been met, the wet well drainage pumps will start and run to empty the respective pump wet wells. The pumps will discharge into the sanitary sewer system, not the equalization tanks. If the wet well level is above the inlet pipe invert elevation (793.0') because the Diversion Pump stopped due to the EQ tank reaching the tank full level or other condition, the sewage grinders will re-start when the associated drainage pump starts. Once the wet well is empty, the pumps and grinders will return to their maintenance mode of operation.

6. Diversion Pump Station Odor Control System: When a relief event is initiated, the odor scrubber fan F-401 will start and run continuously. The fan will stop after an adjustable time period following the end of the relief event.

7. Equalization System:

a. Flow from the diversion station(s) will be transferred to the 10 million gallon capacity equalization tank. The equalization tank will fill to whatever level is required for the current high sanitary sewer flow condition which will be relative to the size and intensity of the associated rainfall event or other high flow condition. Once the reliefevent has ended, the diverted wastewater will be held in the tank until the sanitary sewer flow rates and the PCTRM water levels return to normal levels.

b. Once a relief event is triggered, all equipment at the Equalization Facility will switch from Maintenance Mode to Wet Weather Operating Mode. When a relief event is active, open/close isolation valves FCV-501 FCV- 506 and FCV-507 will be open and Jet Mixing Pump backflushing valves FCV-504, FCV-505 and Flow Return Pump drainage valves FCV-531/532/533 will be closed . Additionally open/close isolation valve FCV-203 will be closed to prevent recirculation of the Wet Well Diversion pump flow back to the South Forks Peachtree Creek Relief Sewer.

c. Equalization Jet Mixing System Operation: When the tank water level rises to the Mixing system start level, the tank jet mixing pump(s) will start in sequence. Once started, the pumps will operate continuously as the tank fills, for as long as wastewater is being stored in the equalization tank, and until the tank is emptied to the mixing system stop elevation. At this level, the mixing system is stopped and the mixing equipment will return to maintenance mode. A low pressure switch shall be installed on each Jet Mix Pump to generate a high priority alarm if there is not enough flow thru the Jet Mix System indicating nozzle blockage.

d. Equalization Tank Odor Control System: As soon as a wastewater from the diversion pumps is diverted to the equalization tank (One of the Diversion Pump starts), the equalization tank odor control fan F-501 will start. The fan will stop after an adjustable time period following the end of the relief event and after the equalization tank is emptied to the South Forks Peachtree Creek Relief Sewer.

H. Equalization Mode

1. Equalization mode will begin when the wet weather relief event/diversion pumping ends.
2. The equalization mixing system and odor control system will be active and there will be no wastewater flowing into or out of the Equalization Tank.
3. The Equalization Facility will switch to flow return mode upon receiving the start command from the Peachtree Creek flow, FIT-110A/B (less than 18 MGD – operator adjustable), and level, LIT-120A or LIT-120B, (less than 5 Feet – operator adjustable) monitoring systems.
   a. Flow will be returned from the equalization tank to the sanitary sewer system by pumping using the Equalized Flow Return Pumps P-531, P-532 and P-533. When the return flow permissive level at the Peachtree Creek Trunk Relief manhole, LIT-120A or LIT-120B is reached and the return flow rate at flow metering structure (FE/FIT-110A/B) is reached, the equalized flow can be returned to the sanitary sewer system.
   b. As soon as flow return is called for, open/close isolation valve FCV-203 will be opened to allow flow of equalized wastewater from the Equalization Tank back to the South Forks Peachtree Creek Relief Sewer. Valve FCV-203 will open slowly to allow draining of the 48" diameter transfer pipe. Once FCV-203 is fully opened, the flow return controls shall start
   c. Under pumped flow control mode, equalized wastewater will be returned to the sewer system by the equalized wastewater flow return pumps. Each pump will be furnished with its own variable frequency drive (VFD) and discharge flow meter (magmeter) FE/FIT-531/532/533.
   d. When a pump is called to start, the pump will start at minimum speed and ramp up to the speed required to match the target flow rate using the associated flow meter FE/FIT-531/532/533.
   e. The Plant Control System will control the equalized wastewater flow return pumps based on the Operator set Required Flow Return Flow Rate and Flow Return Operating Mode (Constant flow or Proportional Flow mode) as described below to determine the number of pumps to operate. Each pump will be controlled independently on flow and can operate between 5 and 11 MGD. The pumps are also limited in operating range when the Equalization Tank is at a high level as there is insufficient discharge pressure to maintain the pumps on the pump curve. Under the high level conditions, the pumps must operate at the minimum speed. So the Equalized return flow pumps cannot start until the required return flow is greater than 9 MGD. The number of pumps and pump speed/ will then be adjusted in conjunction with the other operating pumps to meet the control set point.
   f. Constant Flow Return. In constant flow return mode, the operator will set the desired return flow set point on the master return flow controller FIC-531 . Then the plant control system shall start and stop the equalized wastewater flow return pump and adjust pump speed based on the totalized pump discharge flow rates as monitored by FIT-531/532/533. This constant return flow set point will be adjustable and initially set at 15 MGD (30 MGD is maximum allowable set point). This flow rate will be maintained as long as the sanitary sewer flow rate remains below the adjustable permissive flow limit, initially set at 18 MGD and the PCTRM, LIT-120A or LIT-120B, level is below the flow return permissive level.
   g. Proportional Flow Return. In proportional flow return mode, the amount of total permissive flow in the South Peachtree Creek Trunk sewer shall be set by the operator. The master equalized wastewater flow return flow controller set point FIC-531 shall be

calculated as the operator set total permissible sewer flow rate minus the current actual flow in the sanitary sewer, FE-110A/B. Then the plant control system shall start and stop the equalized wastewater flow return pumps and adjust pump speed based on the totalized pump discharge flow rates as monitored by FIT-531/532/533. All pumps once started will operate at the same flow rate. The minimum required flow rate that must be reached before a pump can start is 9 MGD. This minimum flow rate is required to ensure that the pumps operate at acceptable points on the pump curve.

h. When the tank is at high levels, the pumps must operate within a limited range to ensure they operate at acceptable points on the pump curve. When the EQ tank water level is above 834.0 ft the pumps will operate at a narrow flow range (initially set at 9 to 10 MGD). Under these conditions, the pumps will be started and stopped in increments of 9 MGD and each pump flow rate will be controlled between 9 and 10 MGD. So when the tank level is over 835.0 ft, the permissible return flow rate must reach 9 MGD before the lead pump can start. Then the permissible flow must increase to 18 MGD before the second pump can start and 27 MGD before the third pump can start.

i. Once the tank level drops to 835.0 ft, the flow control will switch to completely modulating control and the speed of all pumps will be adjusted to match the required return flow rate.

j. During flow return operation, the level in the existing downstream Peachtree Creek Trunk Sewer Level Monitoring Manhole (PCTRM) (Radar Level Transmitters LIT-120A and LIT-120B) shall be monitored continuously and the flow return operation disabled if a high level is detected. Similarly the current flow in the sanitary sewer shall be monitored and if reaches its maximum allowed flow set point; the equalized flow return operation shall be disabled. Both of these conditions shall be priority alarmed and the operator must acknowledge and reset the alarms to permit the flow return operation to resume. If a high water level is detected at the PCTRM, the equalized wastewater flow return will be stopped by disabling flow controller FIC-531 , stopping the equalized flow return pumps P-531/532/533 and also closing open/close isolation valve FCV-203. If the equalized wastewater flow return is interrupted by either high flow or high level in the in South Forks Peachtree Creek Relief Sewer, the return flow operation will be discontinued and a new Wet Weather Relief event will start.

k. Pump Stop Operation. When the EQ tank level drops to the pump stop elevation, the pumps will stop sequentially with a minimum adjustable time delay between pump stops to minimize surging.

l. There will be a high high level float switch LSHH-502 at the Cheshire Bridge Junction Chamber that will be hardwired to the flow return pumps to immediately shutdown all operating Flow Return Pumps if it is activated and a high-high level alarm will also be activated.

m. After all pumps have stopped, the motorized pipeline drain valves, FCV-531/532/533 will open allowing the pipeline to drain back into the suction header where it will be pumped out by the drainage pumps.

4. Equalization tank drainage pump operation.

a. There are two equalization tank drainage pumps, P-534/535, provided to empty the bottom of the EQ tank and suction pipeline to the jet mix building. After the equalized wastewater flow return pumps have stopped, the lead equalization tank drainage pump will start followed by the lag pump. Once started, the pumps will be interlocked to stop when the associated motor current from the starter in the MCC drops below its normal operating current (low motor current) for a preset but adjustable period of time. The

low current switch will be bypassed for a short duration at pump start to prevent normal starting motor inrush current from tripping the pump.

b. After both drainage pumps P-534/535 have stopped, the equalized flow return pipe drainage valves, FCV-531/532/533 will be closed and a tank flushing sequence will be initiated as described below.

5. Equalization Tank Flushing Operation

a. A motorized open/close flushing water isolation valve, FCV-511/512/513/514/515/516/517/518, shall be provided for each of the eight (8) flushing zones associated with cleaning out the debris and remaining wastewater left inside the Equalization Tank after a Relief Event. After the EQ tank has been emptied as determined by having the drainage pump P-534/535 stop at the end of their tank emptying drainage cycle, a tank flushing sequence shall be initiated. A tank flushing sequence can also be initiated by the operator. When initiated, the Equalization Tank Automatic Flushing Sequence shall open each of the motorized flushing water control valves in a sequential fashion. Each valve will be opened and the flow rate on the non-potable water magmeter FE/FIT-510 confirmed to be greater than the minimum flushing water flow rate (initially set at 750 GPM per open zone flushing valve). When the flushing flow rate has been confirmed, a zone flushing timer shall be started. When the zone flushing period has expired, the next flushing water valve shall be opened and after an adjustable time period when both zones are flushing simultaneously (initially set at 1 minute) the current valve will be closed.

b. When a flushing sequence has been initiated, a drainage pump start timer will be activated. After the time period expires, the lead EQ tank drainage pump, P-534/535 will be started followed by the lag pump. The time delay is required to allow the flushing water to reach the pump suction piping. The EQ tank drainage pumps will operate until stopped by the discharge low flow switch FSL-534/535. If any pump stops and the flushing sequence is still active, the drainage pump start timer will reset and the pump will be restarted after it times out. When the drainage pumps stop after the EQ tank flushing sequence is complete, the pumps will remain off until the next relief event cycle. The flow return to Peachtree Creek Relief Sewer Motorized Open/close Isolation valve FCV-203 shall remain open during operation of the EQ tank drainage pumps to allow flow from the EQ pipeline Junction Box to flow back to the sanitary sewer.

c. If an EQ tank drainage pump stops 3 times in a short period when called to operate indicating a pipe blockage, the pump will be stopped and an alarm indicated. If the second pump continues to operate, the flushing sequence can continue. If both pumps are shutdown, and not available, the flushing sequence will be prohibited or terminated if in progress.

d. When both EQ tank drainage pumps stop following a EQ tank flushing sequence, flow return to Peachtree Creek Relief Sewer Motorized Open/close Isolation valve FCV-203 shall be remain open for an adjustable period of time (initially set at 2 hours) allowing gravity drainage of the flow return piping back to the sanitary sewer system. At the end of this adjustable period of time FCV-203 will be fully closed so that the system is ready for the next relief event. The time delay is provided to ensure that the entire system is emptied before the system is place off-line.

e. Once this EQ tank flusihing sequence is complete, the Equalization Facility and Diversion Facility equipment will return to dry weather maintenance mode with timers reset accordingly.

6. Jet Mix System Flushing sequence.
   a. Periodically the jet mixing system will require flushing to remove solids that may have accumulated in the mixing nozzles. The operator can input the number of tank/jet mixing cycles between flushing intervals. When the number of operating cycles has been completed, a flushing sequence will proceed as follows. There is also a pressure sensor on each pump discharge line that will indicate an alarm is an abnormally high pressure is detected in either jet mix header indicating nozzle plugging.
   b. When the tank level lowers to the Jet Mixing System Flush elevation (initially set at 20% level), the equalized wastewater flow return pumps will stop under the normal sequence. Once the flow return pumps are stopped, the jet mix pumps will also be stopped. Once the jet mix pumps are stopped, EQ Tank Motorized open/close isolation valve FCV-501 and the pump isolation valves FCV-506/507 will be closed. When all valves are closed the lead jet mix pump flushing valve FCV-504 will open. Once FCV-504 is open the lead flow return pump will start and ramp up to achieve 3500 GPM. After an adjustable flushing time period, FCV-505 will open followed by FCV-504 closing and the flushing timer reset. After the flushing time period expires again, the equalized flow return pump will stop followed by FCV-505 closing. Once FCV-505 closes, FCV-501 and FCV-506/507 will open and once open, the jet mix system and equalized flow return system will restart under the normal start sequence.

7. Diversion Pump Emergency Shutdown.
   a. Secondary shutdown methods shall be provided to stop the Six Diversion pumps to ensure that the equalization tank cannot be overfilled.
   b. There will be a high level switch LSH-501 at the equalization tank that will be wired to the diversion pumps to stop the pumps. This switch will initiate a standard pump stop sequence and a tank full alarm sill be indicated.
   c. There will be a high-high level switch LSHH-501 at a slightly higher elevation to immediately shutdown all operating Diversion pumps if it is activated and a tank high-high level alarm will also be activated.
   d. Additionally, on high high level (LSHH-502) in the Cheshire Bridge Junction Chamber all Diversion Pumps will be disabled by a hardwired interlock.

      The two diversion pump flow meters FE-210/310 shall begin totalizing flow during each Relief event. When an adjustable high volume (initially set at 10.25 million gallons) has been reached, a normal Diversion pump shutdown sequence will be initiated and a tank full alarm indicated.
   e. If the totalized flow exceeds a high-high volume (initially set at 10.55 million gallons) all operating Diversion pumps will be stopped and a high-high volume alarm activated.

2.03 DIVERSION STRUCTURE CONTROL LOGIC

A. Diversion Structure DS-101 and DS-102 Lead/Lag Control (P&ID I-101): There are two diversion structures to divert flow from the South Fork Peachtree Creek Trunk Sewer to the new Liddell Drive Equalization Facility. The plant operations staff shall select which Diversion Structure will be the lead structure for diverting sanitary sewer flow to the Diversion Wet Wells and ultimately the Equalization Facility when either high flow or level in monitored in the South Fork Peachtree Creek Trunk sewer. Normally DS-101 will be the lead diversion structure along with Diversion Wet Well #1. Status of the Lead/Lag Selection shall be clearly visible on the operating graphics as well as indication of a Relief Event in progress.

B. Diversion Structure #1 Diversion Sluice Gates Control - SLG-101-1, d SLG-101-2, SLG-101-3 (P&ID I-101): The Plant Control System shall both monitor and control the position of the motorized modulating sluice gates SLG-101-1, SLG-101-2, and SLG-101-3. Within each Diversion Structure, the three diversion gates will open in a lead/lag1/lag2 fashion to limit surging of flow when diversion is started or ended. When a relief event is initiated and DS-101 is selected as the lead diversion structure, the lead sluice gate will open slowly to divert flow to its Wet Well. Once the lead sluice gate is fully open, the lag1 sluice gate will also slowly open. Then when the lag1 sluice gate is fully open, the lag2 sluice gate shall slowly open. Once all three of the sluice gates in the Lead Diversion Structure are fully open, the lead sluice gate in the lag Diversion Structure shall slowly open to divert flow to its associated Wet Well. Similarly when the lead sluice gate in the Lag Diversion Structure is fully open, the lag1 sluice gate in the Lag Diversion Structure shall slowly open. Similarly, the lag2 sluice gate will slowly open when the lag1 sluice gate is fully open. Upon end of the Relief Event, the gates shall close in a reverse manner. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note this gate can be locally operated by the plant operations staff (there is a remote status input to warn when the gate cannot be control by the Plant Control System). Failure of the Sluice Gates to travel in an appropriate time (adjustable timer initially set to 5 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time these Sluice Gates are not enabled for Remote Control (Local/Remote gate actuator status input).

C. Diversion Structure #2 Diversion Sluice Gates Control - SLG-102-1, SLG-102-2, and SLG-102-3 (P&ID I-101): The Plant Control System shall both monitor and control the position of the motorized modulating sluice gates SLG-102-1, SLG-102-2, and SLG-102-3. Within each Diversion Structure, the three diversion gates will open in a lead/lag1/lag2 fashion to limit surging of flow when diversion is started or ended. When a relief event is initiated and DS-102 is selected as the lead diversion structure, the lead sluice gate will open slowly to divert flow to its Wet Well. Once the lead sluice gate is fully open, the lag1 sluice gate will also slowly open. Then when the lag1 sluice gate is fully open, the lag2 sluice gate shall slowly open. Once all three of the sluice gates in the Lead Diversion Structure are fully open, the lead sluice gate in the lag Diversion Structure shall slowly open to divert flow to its associated Wet Well. Similarly when the lead sluice gate in the Lag Diversion Structure is fully open, the lag1 sluice gate in the Lag Diversion Structure shall slowly open. Similarly, the lag2 sluice gate will slowly open when the lag1 sluice gate is fully open. Upon end of the Relief Event, the gates shall close in a reverse manner. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note this gate can be locally operated by the plant operations staff (there is a remote status input to warn when the valve cannot be control by the Plant Control System). Failure of the Sluice Gates to travel in a appropriate time (adjustable timer initially set to 5 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time these Sluice Gates are not enabled for Remote Control (Local/Remote gate actuator status input).

D. South Fork Flow Measurement - Loop 110 (P&ID I-101): Redundant Marsh McBirney Flo Dar surface radar open channel flow transmitters shall be providedfor the Liddell Drive Equalization Facility and shall be installed in manholes downstream of the Diversion Structure to monitor the flow in the South Fork Peachtree Creek Trunk sanitary sewer system. Two redundant flow transmitters will be provided with separate analog inputs to the Plant Control System. Each transmitter shall be separately wired to PLC analog inputs in the Pump Station Local Control Panel in the Diversion Facility Electrical Building. Both measurements shall be separately monitored and alarmed on the Graphics. For Wet Weather pump operation, the plant operators shall have an Auto/Manual Flow Measurement for Control Selector Switch. In Automatic mode, the highest flow measurement shall be utilized for control. In the manual mode, the operator can selected either flow transmitter for control. Transmitter failure (analog input failure) shall be

monitored and shall prevent that transmitter from being used for control. High and Low alarms shall be configured.

E. Peachtree Creek Trunk Relief Manhole Level Measurement - Loop 120 (P&ID I-101): Two new redundant ultrasonic type level transmitters will be provided for monitor sanitary sewer level in the existing Peachtree Creek Trunk Relief Sewer manhole located in the vicinity of the Cross Creek Housing Division. Because this manhole is some 25,000 feet from the Liddell Drive Project Site, a Telemetry RTU panel will be located at this remote location. The RTU panel will communicate via a telephone type connection to a RTU Panel (to handle the communications and polling of this remote location) in the Diversion Facility Electrical Building. There will also be a RTU Panel in the Equalization Facility Electrical Building that will monitor this remote level measurement. The level transmitters will be wired to 4-20 ma analog inputs in the local RTU panel. Both measurements shall be separately monitored and alarmed on the Graphics. For Wet Weather/Relief Operation, the plant operators shall have an Auto/Manual Downstream Level Measurement for Control Selector Switch. In Automatic mode, the highest level measurement shall be utilized for control. In the manual mode, the operator can selected either level transmitter for control. Transmitter failure (analog input failure) shall be monitored and shall prevent that transmitter from being used for control. Loss of Communication with the remote RTU will be monitored and alarmed when it occurs. Upon loss of communication, the last good level transmitter signal shall be displayed but control based on this level shall be disabled. High and Low alarms shall be configured.

2.04 DIVERSION WET WELL CONTROL LOGIC

A. Wet Well Submersible Pumps Loops 201/202/203/204 (P&ID I-102) and Loops 301/302/303/304 (P&IDs I-103)

1. The Plant Control System shall both monitor and control the starting and stopping and speed of the three submersible diversion pumps (P-201/202/203 in Wet Well # 1 and P-301/302/303 in Wet Well # 2) in each Wet Well to control the Wet Well level or discharge flow depending on operating mode in each Wet Well. The running and trouble status plus status of whether the VFD H-O-R switch is in Remote for each pump will also be monitored. Additionally the status of whether the local E-STOP pushbutton is pressed shall be monitored.

2. The Plant Control System shall both monitor and control the starting and stopping of the single constant speed submersible drainage pump (P-204 in Wet Well # 1 and P-304 in Wet Well # 2) in each Wet Well on a high level start/low level stop basis to remove drainage during dry weather operations and to empty the Wet Well after the Diversion to Equalization is complete. The running and trouble status plus status of whether the Motor Starter H-O-R switch is in Remote for each pump will also be monitored. Additionally the status of whether the local E-STOP pushbutton is pressed shall be monitored.

3. The submersible pumps shall be furnished, in accordance with specification 11199, with vendor furnished pump monitoring controls (enclosed in a separate pump monitoring panel for each pump) that will become hardwired interlocks to the respective VFD (Pumps P-201, P-202, P-203, P-301, P-302, and P-303) The Pump Monitoring Panel will monitor the following conditions:
   a. Stator winding temperature sensor (platinum RTD) x 3 (one per motor phase).
   b. Stator housing leakage (ball float switch).
   c. Motor temperature switch (PTC) for each phase.

d. Support bearing temperature (platinum RTD)

e. Motor junction box leakage (ball float switch).

f. Oil/Inspection Chamber leakage (ball float switch).

g. Main bearing temperature (platinum RTD).

h. Pump vibration sensor (2 axis vibration with velocity readout).

4. Additionally the pumps shall have a low low wet well level hardwired interlock from the Level Monitoring Panel associated with each Wet Well. The Diversion Pumps will have a separate low low level switch from the drainage pumps. LSLL-203 shall be provided for Wet Well # 1 and LSLL-303 for Wet Well # 2 to interlock the respective diversion pumps in each Wet Well (one low low level switch for each set of diversion pumps but a individual interlock contact will be generated in the Level Monitoring Panel for each pump). A separate low low level switch in each wet well shall be interlocked to disable the drainage pump if the level is too low to safely operate (LSLL-204 for Wet Well # 1 and LSLL-304 for Wet Well # 2). Any of these hardwired interlocks or drive internal fault or motor overload will generate a common trouble alarm that will be wired to the Plant Control System as a priority alarm (that will also be logged). Upon receiving this fault signal, the fault status shall be latched to inhibit pump restart until an Operator accesses the situation and determines that it is safe to restart the pump. The associated pump will not be automatically stopped to prevent false alarms/maintenance from disrupting normal pump operation. Note each of these low low level interlocks will be separated wired (from the Level Monitoring Panel) to the Plant Control System for generating a high priority status alarm as well the common fault alarm generated by each VFD or motor stater.

5. To insure that the Equalization Tank does not overflow there will be an interlock from the High Level Switch (LSH-501) on the Equalization Tank to disable the operation of all Diversion pumps on high Equalization Tank level. This high level switch input will initiate a normal sequential shutdown of all operating Diversion Pumps and inhibit any other Diversion Pumps from starting. Additionally, on high high level (LSHH-502) in the Cheshire Bridge Junction Chamber all Diversion Pumps will be sequentially shutdown and pumping of wastewater from the Diversion Wet Wells to the Equalization Tank disabled. If the Relief Event is still active, the Diversion Pump station shall switch to Level Control Mode and the Diversion to South Fork Peachtree Creek Trunk Sewer Motorized Isolation Valve FCV-203 shall be automatically opened to prevent additional flow from being pumped into the Equalization Tank. Once the position of the FCV-203 has changed (it is normally closed when the Diversion Pumps are pumping to the Equalization Tank), the Diversion Pump Station can resume operation in only a LEVEL Control Mode. (Note that the flow thru the Wet Well Magmeter FE/FIT-210 must be disabled when Diversion pumps are not pumping to the Equalization Tank).

6. The Pump Monitors in the Pump Monitoring Panels shall be furnished with a remote monitoring capability via a RS-485 type daisy chained ModBus type network connection to the PLC in the Diversion Facility Local Control Panel. The Plant Control System shall be configured to monitor and display information for each Pump Monitor on a separate Graphical Display. This information shall be available locally at the HMI display on the local control panel and available via the remote connection for the City to display on City of Atlanta Foxboro I/A DCS System at the RM CLayton or other CoA facility as determined in the project.

   a. For estimating purposes assume that each pump will be required to monitor the 4 discrete and 6 analog inputs associated with each MAS unit (assuming the same submersible pumps are provided by ITT Flygt for previous pump station projects) –

following the existing tagging convention – as noted below this is the tagging convention for Pump P-201. Note drainage pumps have different controls than diversion pumps – they are missing motor stator temperature measurements (only temperature switches in each phase wired together as one discrete input), Inspection chamber leakage detection, and pump vibration indication.

i) DI TAH201 – Motor thermals high
ii) DI XA201A – Stator housing leakage
iii) DI XA201B – Connection housing leakage
iv) DI XA201C – Inspection chamber leakage
v) AI TI201A – Motor stator phase 1 temperature
vi) AI TI201B – Motor stator phase 2 temperature
vii) AI TI201C – Motor stator phase 3 temperature
viii) AI TI201D – Main bearing temperature
ix) AI TI201E – Support bearing temperature
x) AI VI201 – Pump vibration

b. Additionally, ModBus communication failure should be alarm – if possible some kind of "watchdog" timer scheme should be utilized – coordinate with ITT Flygt or alternate pump manufacturer. Also if there is a master diagnostic fault signal available for each MAS unit it should also be monitored and alarmed.

c. Engineering Range and Alarm limits should be coordinated with the pump supplier from specification 11199.

7. The VFD's and Motor Starters (for Drainage Pumps) will be hardwired to PLC I/O Points in the Local Control Panel located in the Diversion Facility Electrical Room.. The hardwired interface to the PLC shall include one (1) maintained start/stop contact (maintained start/stop contact powered from the associated motor starter/drive), four (4) dry status contacts (emergency stop status, H-O-R Remote status, and running and trouble indication). Additionally, all variable speed drives will include one (1) isolated speed reference output and one (1) remote speed control input from the Foxboro Control System. All interface contacts shall be rated for 120VAC at 10 amps (i.e. no 24V DC interfaces will be allowable – provide standard industrial grade interposing relays as required).

8. Pump Restart Delay – the submersible pumps will self-drain (no discharge check valve) upon loss of electrical power, or abnormal or normal stopping. There will be a hardwired mechanical restart time delay (initially set for about 90 seconds) in the drives. The restart logic must also be implemented in the Plant Control System to protect the pump from starting against reverse flow. These motors will be nominally specified for 10 starts per hour but because of the motor size, the Pump Sequencing logic should be designed to limit the automatic mode pump starts to only once per a preset but adjustable period of time (initially set at every 6 minutes). This pump restart delay logic may be implemented as part of the associated VFD drive/motor starter.

9. Each Submersible Pump shall be capable of being started by the PLC in the Pump Station Local Control Panel located in the Diversion Facility Electrical Building or via the local H-O-A operating mode selector switch at the associated RVSS or VFD drive. Each pump will have a Hand-Off-Auto (H-O-A) Switch located on the front of each drive. The plant operating philosophy is that local controls take precedence over remote controls in a hierarchical order. Additionally, the Graphics will have its own H-O-A software switch to allow the operators to manually start or disable each pump independently of the automatic

pump sequencing logic. Also, note that there is a local Emergency Stop Pushbutton associated with each pump that can disable pump operation.

10. The two Diversion Wet Well Drainage pumps will be furnished with flushing water solenoids to add in removing debris from the Wet Wells and associated pump discharge pumping when emptying the Wet Well after a relief event has occurred and during the periodic cleanout mode of the Wet Well between Relief Events. A flushing water solenoid (SV-204 for Pump P-204 and SV-304 for Pump P-304) will be hardwired to the associated pump motor starter and will automatically open the flushing water supply each time the pump is running. There will be no control of these solenoids from the Plant Control System. The solenoids valves will have manual overrides to permit operating testing/manual operation of the flushing system.

B. Wet Well Level/Flow Control of Diversion Pump Loops 201/202 (P&ID I-201) and Loops 301/302 (P&ID I-301): Wet Well level/flow control shall start and stop and control the speed of the submersible diversion pumps (P-201/202/203 or P-301/302/303) as noted below.

1. Two Redundant Radar (microwave) level transmitters are located in each Wet Well. All four level transmitters (two per Wet Well) will be identical so they can be installed in any location.

2. The Radar level measurement selected for control in each Wet Well shall be selectable by the plant operators to permit maintenance. There will be selector switch on the Pump Station Graphics to select the transmitter used for pump control. This selector switch shall allow any of the two transmitters to be manually selected for control or automatic level transmitter selection based on lowest level. Failure of any transmitter shall inhibit from being used for pump control and shall generate a high priority alarm. Additionally, generate a deviation alarm for each transmitter if it differs from the selected level transmitter signal by a tunable amount (initially set at 4 inches) – deviation alarm will be disabled if transmitter failure is detected. The level transmitter input to the Plant Control System will be in terms of feet of water above the bottom of the Wet Well. There will also be a calculation of volume of wastewater stored in the wet well based on the Selected Level transmitter used for Control

3. Approximate Wet Well operating levels (in Elevation above sea level)

Top of Wet Well	824.5 Feet
Bottom of Wet Well	785.0 Feet
Diversion Pump Settings	
High High Water Level Alarm	811.0 Feet
Lead Diversion Pump Start (Rising Level)	790.0 Feet
All Diversion Pumps Stop (Falling Level)	788.75 Feet
Low Water Level Alarm (Diversion Pumps)	788.33 Feet
Level Control Setpoint	795.0 Feet
Drainage Pump Settings	
High High Water Level Alarm (Dry Weather)	789.0 Feet
Drainage Pump Start	786.75 Feet
Drainage Pump Stops (Falling Level)	786.25 Feet
Low Low Water Level Alarm (Drainage Pumps)	786.0 Feet

4. To measure the amount of wastewater being pumped out of each Wet Well an inline magnetic flow meter will be installed on the discharge of the Diversion Pumps for each Wet Well. Each Wet Well can operate in either level or flow control mode depending on the amount of excess wastewater in the South Fork Peachtree Trunk Sewer above the operator entered permissible normal flow rate and how fast that flow is being diverted to each Wet Well. Since the diversion of wastewater to each Wet Well is by gravity, there is no control of the flow coming into the Wet Well only control of the amount of flow being pumped to the Equalization Facility. The operator can select which mode each Wet Well can initially be operating in.

5. To accommodate the varying conditions there will be two modes of control, flow and level. In flow control mode, the pump operation will be controlled by the discharge flow rate with a set point calculated from the difference between the operator entered permissible sewer flow rate and the current sewer flow as measured at flow metering structure (flow measurement FIT-110A or FIT-110B). The diversion pump operation will be controlled to pump all flow above the permissible flow set point to the equalization Facility. In level control mode, the pumps will operate to maintain the set wet well level. If a wet well is operating in Flow Control Mode and the calculated flow set point reaches minimum operating flow for a single pump (as set by the manufacturer based on the Equalization Tank Level – pump discharge head) for a adjustable period of time, that Wet Well will be switched to Level Control Mode. The two wet wells can operate in different modes to suit the current flow requirements. The non-operating controller shall be switched to output tracking mode so that there will be a bump less transfer should it again be selected to control the pumping operation.

6. A total of six diversion pumps are provided in the diversion pump station, three in each wet well (P-201, P-202, P-203 and P-301, P-302, P-303). Normally, five of the diversion pumps will operate as duty pumps and one will be standby. All six pumps will be configured the same for pump operations; the capacity of the standby pump will simply not be required for operation to meet normal process conditions. The pumps in each wet well will be configured as LEAD, LAG1, and LAG2. The initial LEAD/LAG1/LAG2 selection will be determined by the Operator. The two Wet Wells will also be operated as LEAD/LAG (matching their associated Diversion Structure). The lead Wet Well will be the one associated with the lead diversion structure.

7. As the wet well begins to fill, the lead pump in that Wet Well will start at the minimum speed when the level reaches the pump start level. The lead pump will operate at minimum speed for an adjustable period of time (initially set at 10 minutes) to fill the transfer pipeline. Whether in Level or Flow Control Mode, the output of the selected controller shall control the speed of the Diversion Pump or Pumps that are currently operating. When the controller output reaches full permissible pump speed (pre-set adjustable setting – assume 95% for initial value – also see pump maximum speed limits based on variable discharge head requirements as noted in paragraph 12 below) for at pre-set period of time (initial value of 1 minute), additional pumping capacity shall be added by starting the next pump in the sequence and ramping down the controller output slightly to accommodate the increased pumping capacity being added by starting another pump. Once the new pump has started and reached its speed set point, the selected controller will be released to resume control. The LAG2 pump will start similarly if the controller output again reaches the full permissible pump speed for a pre-set but adjustable period of time (initially set at 1 minute). When the Last LAG pump in both Wet Wells has started and the variable speed pumps are operating at full allowable speed for an adjustable period of time (initial value of 5 minutes), a high priority alarm shall be generated on the plant control system.

8. The lag diversion structure and associated wet well will be called to operate whenever either of the following conditions occurs (the pumps in the lag diversion wet well shall operate the same as described for the lead wet well above):
   a. The wet well level in the lead Wet Well rises above the level control set point and the flow rate at flow metering structure (FE/FIT-110A/B)still exceeds the permissible flow rate. This will occur if the flow rate from the diversion structure is not adequate to meet the diversion flow rate required.
   b. All available pumps in the lead wet well are called to operate and reach full speed (or maximum allowable speed) and the permissible flow rate cannot be maintained at the flow metering structure (FE/FIT-110A/B). This will occur if the required diversion flow rate exceeds the capacity of the available pumps in the lead wet well.

9. When the measurement for the selected controller drops below set point, the variable speed pump(s) will slow till it reaches its pre-determined minimum operating speed. If the measurement is still dropping and the variable speed pump has set at its minimum operating speed (preset adjustable level/speed controller output – initial value of 35% – also see pump minimum speed limits based on variable discharge head requirements as noted in **paragraph 12 below**) for a preset adjustable period of time (initial value of 1 minute), the last pump started will be stopped and controller output frozen at its current output. Once that pump has stopped, the controller will be released to resume control. LAG pumps shall continue to be stopped in a similar manner if the controller measurement continues to stay below set point and the output reaches minimum operating speed. When the level in the Wet Well reaches its minimum pump operating level, the lead pump shall be stopped. A high priority alarm shall be generated to notify the operator that that Wet Well has gone out of service due to insufficient flow into the Wet Well (in case of possible pump failure or blockage in the flow to the Wet Well.

10. If any of the pumps does not start (running feedback from starter) within a pre-set time delay after being called to run (initially set to 30 seconds), the next pump in the sequence shall be called to run, and the corresponding pump common trouble alarm (combined with the starter common trouble status signal) shall be activated. This pump fault alarm shall be latched until reset by the Operator. The selection of LEAD pump will change automatically if the LEAD pump fails to start or fails during normal pump operation.

11. Automatic Lead-Lag Alternation: When a pump fails to start or fails to run during required normal operation, the selection of LEAD/LAG1/LAG2 pumps shall change automatically. Also when all three pumps are shutdown during normal operation, the LEAD/LAG1/LAG2 pump selection shall be automatically changed.

12. The Diversion Pumps are variable speed due to the required operation over a very large range of discharge head requirements. The PLC shall be programmed to vary the speed command output to the VFDs according to the selected Wet Well Level/Flow controller output. The Pump manufacture during plant start-up will provide a table of minimum and maximum speed ranges for the VFD's that the pumps and associated VFDs can safely operate at a specified discharge pump head (normally wastewater level in the Equalization Tank). The PLC shall be programmed to adjust the high and low analog output limits to keep the pump speed above and below these vendor furnished operating limits at the variable discharge head conditions specified. The operator may choose to adjust the pump speed within these limits as the pumps operate.

13. A Magnetic flow meter (magmeter) (FE/FIT-210 and FE/FIT-310) will be used to measure the wastewater being pumped from each Diversion Wet Well by the associated Diversion Pumps. The flow tube will be located below ground in the Diversion Facility Valve Room.

The magmeter transmitters are currently located in the Diversion Facility Electrical Room.. The flow transmitter output will be wired to the PLC local control panel in the Diversion Facility Electrical Room for monitoring and control. High and Low absolute alarms shall be confirmed (initially set to 90% and 10% level respectively). Since the Equalization Facility is normally offline and the wastewater in the associated piping is normally drained back to the South Fork Peachtree Creek Sanitary Sewer when the Facility is offline, the plant control system shall disable the indication of flow thru the magmeters until there is a minimum adjustable level in the Equalization Tank (initially to be set at 5% of level). Flow Control will be disabled when the measurement signal is not of good quality. Both of the Diversion Facility Wet Wells will be furnished with similar magmeter on discharge of its associated set of three Diversion Pumps. Because the Return to South Fork Peachtree Creek Sanitary Sewer Isolation Valve FCV-203 is downstream of FE/FIT-210, the flow metering reading will be disabled when the Equalization Tank is operating in its Pump Flow Return to sewer operating mode (i.e. there will be reverse flow thru this magmeter). Additionally during normal operation of the diversion pumps, total flow thru each flow meter shall be totalized (provide low flow cutoff for totalization set at 10% initially). Should an adjustable high total discharge flow limit be reached (operator adjustable but initially set at 10.25 Million Gallons), the diversion pumps shall be sequentially shutdown in Last on – First Off fashion till the all the diversion pumps have been shutdown. If the totalized flow exceeds a high-high volume (initially set at 10.55 million gallons) all operating Diversion pumps will be stopped immediately and a high-high pumped flow alarm activated.

14. To insure that the Equalization Tank does not overflow there will be several secondary shutdown interlocks to disable flow from the Diversion Pumps from being pumped to the EQ Tank. There will be a high level switch LSH-501 mounted on the top of the Equalization Tank. When this switch (LSH-501) detects high EQ tank level, the Plant Control system shall initiate a software interlock to sequentially stop all of the diversion pumps with a time delay between pump stops. An EQ Tank full high priority alarm shall be generated. Additionally, another high level switch LSHH-501 set at a slightly higher level will be hardwired to each Diversion Pump VFD to disable the operation of all Diversion pumps on high high Equalization Tank level. Additionally, on high high level (LSHH-502) in the Cheshire Bridge Junction Chamber all Diversion Pumps will be disabled via a hardwired interlock. If the Relief Event is still active, the Diversion Pump station shall switch to Level Control Mode and the Diversion to South Fork Peachtree Creek Trunk Sewer Motorized Isolation Valve FCV-203 shall be automatically opened to divert flow from the EQ tank to the South Peachtree Creek Trunk Sewer. Once the position of the FCV-203 has changed from closed to open, the Diversion Pump Station can resume operation in only a LEVEL Control Mode. (Note that the flow thru the Wet Well Magmeter FE/FIT-210 must be disabled when Diversion pumps are not pumping to the Equalization Tank).

C. Level Monitoring Panels Loops 201, 202, (P&ID I-102) and Loops 301, 302 (P&ID I-103): A Level Monitoring Panel shall be located in the Diversion Facility Electrical Building to allow local (to Submersible Pump Drives) monitoring of wet well level in case of PLC failure and to provide multiple hardwired low low wet well level hardwired interlock signals to all drives. There will be separate Level Monitoring Panel for each Wet Well. For Redundancy there will be two Radar (microwave) level transmitters installed in each Wet ell. Each level transmitter shall be wired to its associated Level Monitoring Panel with a front mounted panel indicator displaying level in Feet of Water above the bottom. The Level transmitter signal will then be output via signal isolators to analog PLC Inputs inside the Local Control Panel in the Diversion Facility Electrical Building. Additionally two float level switch will be located inside each Wet Well to provide low low water level hardwired interlock protection to all of the submersible pumps. The

Diversion Pumps will have a separate low low level switch from the Drainage Pumps. LSLL-204 shall be provided for Wet Well # 1 Diversion Pumps and LSLL-304 for Wet Well # 2 Diversion Pumps. A separate low low level switch in each wet well shall be interlocked to disable the drainage pump if the level is too low to safely operate (LSLL-203 for Wet Well # 1 and LSLL-303 for Wet Well # 2). The Level Monitoring Panel shall be fabricated to generate an audible alarm plus strobe beacon light indication when either low low signal is received (open on low low level to alarm). The low low level interlock signal for the diversion pumps shall be designed to connect to a multiple output contact relay to provide a separate dry relay contact output for each Diversion Pump hardwired interlock and an additional relay contact output to provide remote low low level alarming via a PLC Input in the Local Control Panel located in the Electrical Building. Similarly the low low level hardwired interlock input for the drainage pump shall be wired to a relay that shall provide a relay output to the PLC for remote alarming as well as the hardwired interlock signal to be sent to the associated RVSS drive. Detection of low low water level by the Plant Control System shall generate a high priority alarm.

D. Wet Well Gas Monitoring Panels - Loops 210, 211, 212 (P&ID I-102) and Loops 310, 311, 312 (P&ID I-103): A Hazardous Gas Monitoring Panel shall be provided for each Diversion Pump Station Wet Well and will be local to each Wet Well. Each Gas Monitoring Panel shall detect and monitor the Combustible Gas Level and Hydrogen Sulphite (H2S) Concentration inside the Wet Well. Combustible Gas Detection will be monitored via Infrared Absorption type Sensor located above the Wet Well Odor concrete cover. A Gas Sampling System and associated explosion proof sampling pump shall be utilized to draw a sample from inside the Wet Well thru the Combustible Gas Sensor before returning to the Wet Well. Two Combustible Gas Detection Systems for each Wet Well will be provided one calibrated for Methane Gas and another for Petroleum Vapors. Additionally, a separate Gas Sampling System and associated explosion proof sampling pump shall be furnished for a Hydrogen Sulphide (H2S) Gas Sensor. The actual Analyzer Transmitters and relays for local alarming and remote monitoring will be located in the Gas Monitoring Panel. Per NFPA 820, local and remote alarming of combustible gas detection shall be provided via the Gas Monitoring Panel. A discrete input from both sampling systems shall be wired to the Plant Control System to indicate sampling system failure/low flow alarm. Both Analog and Discrete inputs from the Combustible Gas Transmitters (one for Methane LEL and another for Petroleum LEL) and H2S Gas Transmitters located remotely in Gas Monitoring Panel shall be wired to the Plant Control System for remote monitoring and alarming. Detection of High Combustible Gas Levels or High H2S Concentrations shall generate a high priority alarm.

E. Diversion Wet Well Sluice Gates Control - SLG-201/202 (P&ID I-102), SLG-203 (P&ID I-102), and SLG-301/302 (P&ID I-103): Each wet well is provided with two inlet slide gates (SLG-201 and SLG-202; SLG-301 and SLG-302) for maintenance isolation. Additionally, there will be a Wet Well Interconnect Sluice Gate SLG-203 to equalize the level in the two wet wells as required. Each gate is installed upstream of a sewage sludge grinder and can be used to isolate the respective grinder or the entire wet well if both gates are closed. The gates are normally in the open position (except for the Interconnect Sluice Gate SLG-203 which will normally be closed)The gates can be operated either locally or remotely. The Plant Control System shall both monitor and control the position of the motorized sluice gates. Discrete Inputs and Outputs shall be configured as shown in the I/O List. When the plant control system opens the lead sluice gate in the associated Diversion Structure, the associated sluice gates in the associated Diversion Wet Well will be automatically opened if not already opened. A High Priority Alarm shall be generated if neither sluice gate is fully opened when the associated Diversion Structure diverts flow to the Wet Well. When Wet Well is taking out of service for diverting flow to the Equalization Facility, the sluice gates will be left in their current position. A high priority alarm

shall be generated any time these Sluice Gates are not enabled for Remote Control (Local/Remote gate actuator status input).

F. Diversion Wet Well Sewage Grinders Control -WWG-201/202 (P&ID I-102) and WWG-301/302 (P&ID I-103): Each wet well is provided with two wastewater grinders (WWG-201 and WWG-202;, WWG-301 and WWG-302). Each grinder is provided with a vendor furnished local control panel that controls grinder operations. The grinders will start at the same time a slide gate in the associated diversion structure is instructed to open. The grinders will operate continuously once they are started and will be shut down when the last diversion pump in the wet well stop. The sewage grinders will also restart when the wet well drainage pumps are started to empty the wet well at the end of a relief event. The local control panel will be hardwired to PLC I/O Points in the Local Control Panel located in the Diversion Facility Electrical Room. The hardwired interface to the PLC shall include one (1) maintained start/stop contact (maintained start/stop contact powered from the associated motor starter/drive) and three (3) dry status contacts (H-O-R Remote status, and running and trouble indication). A High Priority Alarm shall be generated if any sewage grinder is not operating when the associated Wet Well is in service (unless its associated sluice gate has been manually closed). A high priority alarm shall be generated any time these Sewage Grinders are not enabled for Remote Control (Local/Remote selector switch status input).

G. Diversion to South Fork Peachtree Creek Trunk Sewer Motorized Isolation Valve FCV-203 (P&ID I-102): The Plant Control System shall both monitor and control the position of the motorized open/close valve FCV-203 that controls flow from the Diversion Pumps or pumped flow return from the Equalization Tank. The isolation valve is normally closed but opens when the Diversion Pumps are doing their initial filling of the Discharge piping back to the South Fork Peachtree Creek Sanitary Sewer or when the Equalization Tank is enabled for pump flow return back into the Sanitary Sewer. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note this motorized valve can be locally operated by the plant operations staff (there is a remote status input to warn when the valve cannot be control by the Plant Control System). Failure of the motorized valve to travel in an appropriate time (adjustable timer initially set to 2 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time this valve is not enabled for Remote Control (Local/Remote valve status input).

H. Diversion Valve Room Sump Pump P-205 (P&ID I-102): A vendor furnished plug-in type automatic starting constant speed sump pump system shall be provided for the Equalization Diversion Valve Room. This pump will require a local GFI Protected electrical power outlet to plug in the attached 20 foot power cable and will include integral start/stop float level switches for automatic sump pump operation. The Instrument Contractor shall provide a high high level float level switch LSHH-205 to monitor the sump in case of pump failure. The high high level float switch shall be wired to the PLC local control panel in the Diversion Facility Electrical Building for remote monitoring The high high level switch input shall generate an alarm when high hjgh level is sensed (open to alarm on high high level).

2.05 EQUALIZATION FACILITY CONTROL LOGIC

A. Equalization Tank Level Loop 501 (P&ID I-104): A radar (microwave) type level transmitter will be used to measure the wastewater level in the Equalization Tank. The transmitter sensor shall be bolted to a 3 inch flanged connection on top of the tank and the level transmitter shall be located beside the tank mounted 4 foot 6 inches off the ground to provide local level indication. The level transmitter output will be wired to the PLC local control panel in the Equalization Facility Electrical Building for monitoring and control. High and Low absolute

alarms shall be confirmed (initially set to 90% and 10% level respectively). A low level signal from the transmitter input shall be used to enable the Equalization Mixing pump operation.

B. Equalization Tank High Level Interlocks Loop 501 (P&ID I-104): A Capacitance High Level Switch (LSH/LSHH-501) will be mounted on top of the Equalization Tank to disable the Diversion Pumps (P-201/202/203/301/302/303) on high level or high high level. Both the High and High High Level switch inputs shall also be wired to to the PLC local control panel in the Equalization Facility Electrical Building for remote alarming and interlocking. Either level switch input (wired to be open to alarm) shall generate a high priority alarm (that will also be logged). When this switch (LSH-501) detects high EQ tank level, the Plant Control system shall initiate a software interlock to sequentially stop all of the diversion pumps with a time delay between pump stops. A separate contact off the High High Level Switch LSHH-501 shall be wired to high EQ Tank level interlocking relays (See Electrical Elementary E7-605) in the PLC Cabinet that shall multiplex the high level switch as a separate hardwired interlock to each VFD to disable the operation of all Diversion pumps on high high Equalization Tank level.

C. Cheshire Bridge Junction Chamber: High High Level Interlocks Loop 502 (P&ID I-104): A float level switch (LSHH-502) will be mounted in the Junction Box to disable the Diversion Pumps (P-201/202/203/301/302/303) on high high level. The Equalized Flow Return pumps will also be disabled on high high level. This level switch will be wired to the high EQ Tank level interlocking relays (See Electrical Elementary E7-605) inside the PLC local control panel in the Equalization Facility Electrical Building for interlockin and remote alarming. A high priority alarm (that will also be logged) will be generated when high high level is detected. A four pole multiplexing relay in the PLC Cabinet shall repeat the high high level status of this float level switch as separate hardwired high level interlocks to each of the Equalized Wastewater Flow Return Pump VFD's (VFD-531, 532, 533).

D. Equalization Jet Mixing Pumps Loops 501/502 (P&ID I-104): The Plant Control System shall start and stop and monitor the operation of the constant speed equalization jet mixing pumps P-501 and P-502. Each mixing pump shall have a motor starter in the 480V MCC located in the Equalization Facility Electrical Building. Each motor starter will be hardwired to PLC I/O Points in the Local Control Panel located in the Equalization Facility Electrical Room. The hardwired interface to the PLC shall include one (1) maintained start/stop contact (maintained start/stop contact powered from the associated motor starter/drive) and three (3) dry status contacts (H-O-R Remote status, and running and trouble indication). When the level in the Equalization Tank rises to the Mixing system start level, the tank mixing pumps available for operation will start sequentially with a short adjustable time delay between starts.. Once started, the pumps will operate continuously as the tank fills and for as long as wastewater is being stored in the equalization tank. When the tank is emptied back into the South Fork Peachtree Creek Trunk Sewer, the mixing system shall continue to mix the contents of the Equalization tank until the level is drawn down to the mixing system stop elevation (pre-set adjustable level where in the mixing pumps will be stopped sequentially and their operation returned to offline maintenance mode.

E. Equalization Jet Mix Pump high Discharge Pressure Loops 501/502 (P&ID I-104): A diaphragm operated high pressure switch with attached diaphragm seal will be installed on the discharge of each Jet Mix Pump to sense improper operation of the Jet Mix System (low circulation flow – possible plugging). Both high pressure switches will be wired to the PLC local control panel in the Equalization Facility Electrical Building for remote monitoring The pressure switch input shall generate a high priority alarm when high discharge pressure is sensed (open to alarm on high pressure).

F. Equalization Jet Mix Pumps Motorized Drainage Valves FCV-504 and FCV-505 (P&ID I-104): The Plant Control System shall both monitor and control the position of the motorized open/close valves FCV-504 (on Pump P-501) and FCV-505 (on Pump P-502) on the Jet Mix Pumps. When the Jet Mixing System is shutdown on low Equalization Tank level, both motorized drainage valves will be opened to drain the Jet Mixing System piping back into the gravity return line to the South Fork Peachtree Creek Sanitary Sewer. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note these valves can be locally operated by the plant operations staff (there is a remote status input to warn when the valve cannot be control by the Plant Control System). Failure of the motorized valves to travel in an appropriate time (adjustable timer initially set to 2 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time these valves are not enabled for Remote Control (Local/Remote valve status input).

G. Equalization Jet Mix Pumps Discharge Isolation Valves FCV-506 and FCV-507 (P&ID I-104): The Plant Control System shall both monitor and control the position of the motorized open/close valves FCV-506 (on Pump P-501) and FCV-507 (on Pump P-502) on the Jet Mix Pumps. When the associated jet mix pump is started, each associated discharge isolation valve shall open automatically. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note these valves can be locally operated by the plant operations staff (there is a remote status input to warn when the valve cannot be control by the Plant Control System). Failure of the motorized valves to travel in an appropriate time (adjustable timer initially set to 2 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time these valves are not enabled for Remote Control (Local/Remote valve status input).

H. Equalization Facility Motorized Valve FCV-501, and FCV-503 (P&ID I-104): The Plant Control System shall both monitor and control the position of the motorized open/close valve FCV-501 (Equalization Tank Isolation). This motorized open/close valve shall normally be normally open but can be closed by the Operator to do maintenance on the outlet piping from the EQ Tank.. As long as there is wastewater in the Equalization Tank isolation valve FCV-501 shall remain open to allow the Jet Mix System to recirculate the wastewater in the Tank to limit settling of the suspended solids in the Equalized Wastewater. The Plant Control System shall also monitor and control the position of motorized modulating control valve FCV-503. FCV-503 shall normally be closed but will open for modulating control when the Equalization System is conducting a Relief Event and the Equalization tank is enabled for Gravity Return to the Sanitary Sewer. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note this motorized valve can be locally operated by the plant operations staff (there is a remote status input to warn when the valve cannot be control by the Plant Control System). Failure of the motorized valve to travel in an appropriate time (adjustable timer initially set to 2 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time this valve is not enabled for Remote Control (Local/Remote valve status input).

I. Equalized Wastewater Flow Return Pumps Loops 531/532/533 (P&ID I-105): The Plant Control System shall start and stop and monitor the operation of the variable speed Equalized Wastewater Flow Return pumps P-531, P-532, and P-533. Each flow return pump shall have a variable speed drive (VFD) located in the Equalization Facility Electrical Building. Each VFD will be hardwired to PLC I/O Points in the Local Control Panel located in the Equalization Facility Electrical Room. The hardwired interface to the PLC shall include one (1) maintained start/stop contact (maintained start/stop contact powered from the associated VFD) and three (3) dry status contacts (H-O-R Remote status, and running and trouble indication) and analog input for speed monitoring and analog output for speed control. When the flow and level in the Peachtree Creek Trunk Sewer returns to normal operating limits and the Operator has initiated Pump Flow Return,

the flow return pumps will be automatically started in a Lead, Lag1, Lag 2 fashion according to the Pump Flow Return Operating Logic. There will be preset but operator adjustable time delay between successive pump starts. Once started, the pump shall operate continuous as long as there is level in the EQ tank and as long as the Flow and Level Limits in the Peachtree Creek Trunk Sewer are not exceeded. When either condition is meet (low EQ tank level or flow/level limits exceed), the flow return pumps will be stopped sequentially and their operation returned to offline maintenance mode.

J. Equalized Wastewater Flow Return Pumps Motorized Dischaarge Pipeline Drainage Valves FCV-531, FCV-532, and FCV-533 (P&ID I-105): The Plant Control System shall both monitor and control the position of the motorized open/close valves FCV-531 (on Pump P-531), FCV-532 (on Pump P-532), and FCV-533 (on Pump P-533). When all three flow return pumps have shutdown, the motorized discharge pipeline drainage valves shall open for a pre-set but adjustment period of time (initially set at 2 minutes) to allow the discharge pipeline to drain back into the suction header where it will be pumped out by the EQ Tank drainage pumps. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note these valves can be locally operated by the plant operations staff (there is a remote status input to warn when the valve cannot be control by the Plant Control System). Failure of the motorized valves to travel in an appropriate time (adjustable timer initially set to 2 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time these valves are not enabled for Remote Control (Local/Remote valve status input).

K. Equalization Pumped Flow Return Flow Control Loop 531 (P&ID I-105):

1. After the period of high flow in the South Fork Peachtree Creek Trunk sewer has passed by observing that sewer flow (as observed by FE-110) has gone below permissible limits and the level monitored in the existing Peachtree Creek Trunk Relief Manhole (PCTRM) has reached normal levels, the Equalization Facility shall enter its storage mode until Flow Return to the South Fork Peachtree Creek Trunk sewer is initiated. Flow will be returned from the equalization tank to the sanitary sewer system by pumping using the Equalized Wastewater Flow Return Pumps P-531/532/533..
2. To measure the amount of wastewater being pumped out of the EQ tank, an inline magnetic flow meter will be installed on the discharge of each Flow Return pump. Each flow transmitter output will be wired to the PLC local control panel in the Equalization Facility Electrical Building for monitoring and control. High and Low absolute alarms shall be confirmed (initially set to 90% and 10% level respectively). The sum of all three flowmeters shall be calculated and used to generate the master Flow Return Flow Controller input measurement. Totalized Flow Return Flow shall also be calculated and displayed. Flow Control and totalized will be disabled whenever any of the flow measurement signal is not of good quality
3. When the return flow permissive level at the Peachtree Creek Trunk Relief manhole, LIT-120A or LIT-120B is reached and the return flow rate at FE-110 is reached, the equalized flow can be returned to the sanitary sewer system. When flow return starts, open/close motorized isolation valve FCV-203 will be opened to allow flow of equalized wastewater from the Equalization Tank back to the South Forks Peachtree Creek Trunk Sewer. Stored Equalized Wastewater will be returned to the South Peachtree Creek Trunk sewer via pump return flow utilizing a master flow controller that shall monitor the Equalized Wastewater Storage Tanks outlet flow (summing the flow return discharge flow Magmeters 0 FIT-531/532/533) and modulating the speed of the three flow return pumps. There will be two

methods of flow return control designed into the system. The first is constant flow return and the second is flow proportional control.

4. Constant Flow Return. In constant flow return mode, the operator will set the desired return flow set point on the master Flow Return flow controller FIC-531 and the speed of the Flow Return Pumps will modulate to maintain this desired flow set point. Then the plant control system shall start and stop the equalized wastewater flow return pump and adjust pump speed based on the totalized pump discharge flow rates as monitored by FIT-531/532/533. This constant return flow set point will be adjustable and initially set at 15 MGD (30 MGD is maximum allowable set point). This flow rate will be maintained as long as the sanitary sewer flow rate remains below the adjustable permissive flow limit, initially set at 18 MGD and the PCTRM, LIT-120A or LIT-120B, level is below the flow return permissive level..

5. Proportional Flow Return. In proportional flow return mode, the amount of total permissive flow in the South Peachtree Creek Trunk sewer shall be set by the operator. The master equalized wastewater flow return flow controller set point FIC-531 shall be calculated as the operator set total permissible sewer flow rate minus the current actual flow in the sanitary sewer, FE-110A/B. Then the plant control system shall start and stop the equalized wastewater flow return pumps and adjust pump speed based on the totalized pump discharge flow rates as monitored by FIT-531/532/533. All pumps once started will operate at the same flow rate. The minimum required flow rate that must be reached before a pump can start is 9 MGD. This minimum flow rate is required to ensure that the pumps operate at acceptable points on the pump curve.

6. When the tank is at high levels, the pumps must operate within a limited range to ensure they operate at acceptable points on the pump curve. When the EQ tank water level is above 834.0 ft the pumps will operate at a narrow flow range (initially set at 9 to 10 MGD). Under these conditions, the pumps will be started and stopped in increments of 9 MGD and each pump flow rate will be controlled between 9 and 10 MGD. So when the tank level is over 835.0 ft, the permissible return flow rate must reach 9 MGD before the lead pump can start. Then the permissible flow must increase to 18 MGD before the second pump can start and 27 MGD before the third pump can start.

7. Once the tank level drops to 835.0 ft, the flow control will switch to completely modulating control and the speed of all pumps will be adjusted to match the required return flow rate.

8. During flow return operation, the level in the existing downstream Peachtree Creek Trunk Sewer Level Monitoring Manhole (PCTRM) (Radar Level Transmitters LIT-120A and LIT-120B) shall be monitored continuous and the flow return operation disabled if a high level is detected. Similarly the current flow in the sanitary sewer shall be monitored and if reaches it maximum allowed flow set point, the gravity return operation shall be disabled. Both of these conditions shall be priority alarmed and the operator must acknowledge and reset the alarms to permit the gravity flow return operation to resume. If a high water level is detected at the PCTRM, the equalized wastewater flow return will be stopped by disabling the master Flow Return flow controller FIC-531 and ramping the pump speed to minimum before disabling all three flow return pumps and also closing open/close isolation valve FCV-203. If the equalized wastewater flow return is interrupted by either high flow or high level in the in South Forks Peachtree Creek Trunk Sewer, the return flow operation will be discontinued and a new Wet Weather Relief event will start.

9. When the equalization tank level reaches a low level stop return flow set point, the master Flow Return flow controller FIC-531 shall be disabled and the Equalization System shall return to its offline stand-by operation. Open/Close isolation valve FCV-203 shall be closed to isolate flow from the Equalization Tank

L. Equalization Jet Mix Pump Station Sump Pump P-503 (P&ID I-104): A vendor furnished plug-in type automatic starting constant speed sump pump system shall be provided for the Jet Mix Pump Station Washdown Sump. This pump will require a local GFI Protected electrical power outlet to plug in the attached 20 foot power cable and will include integral start/stop float level switches for automatic sump pump operation. The Instrument Contractor shall provide a high high level float level switch LSHH-503 to monitor the sump in case of pump failure. The high high level float switch shall be wired to the PLC local control panel in the Equalization Facility Electrical Building for remote monitoring The high high level switch input shall generate a high priority alarm when high hjgh level is sensed (open to alarm on high high level).

M. Equalization Tank Drainage Pumps Loops 534/535 (P&ID I-105): The Plant Control System shall start and stop and monitor the operation of the constant speed Equalization Tank drainage pumps P-534 and P-535. Each mixing pump shall have a motor starter in the 480V MCC located in the Equalization Facility Electrical Building. Each motor starter will be hardwired to PLC I/O Points in the Local Control Panel located in the Equalization Facility Electrical Room. The hardwired interface to the PLC shall include one (1) maintained start/stop contact (maintained start/stop contact powered from the associated motor starter/drive) and three (3) dry status contacts (H-O-R Remote status, and running and trouble indication) as well as motor current input. When the level in the Equalization tank drops to below the Flow Return Pump operating level and all the Flow Return Pumps have stopped, The EQ Tank Drainage Pumps shall start sequentially (selected lead pump first then lag pump). The pumps shall be interlocked to stop on low motor current which should indicate when the EQ Tank and suction piping have been pumped dry (causing the motor current to drop below its normal operating current). Having both pumps stop on low motor current will disable the EQ Tank Drainage Pump operation. The drainage pumps will also operate during the EQ Tank Flushing Sequence described below to pump flushing water and any collected sediment from the EQ tank and discharge piping to the EQ pipeline junction box and then thru the bidirectional Equalization System Supply/Flow Return Piping back to the Peachtree Creek Relief Sewer (thru the pipeline to the Diversion Facility and Motorized Isolation Valve FCV-203).

2.06 EQUALIZATION FACILITY TANK FLUSHING SYSTEM CONTROL LOGIC

A. Equalization Tank Flushing Flow Loop 510 (P&ID I-108): A Magnetic flow meter (magmeter) will be used to measure the non-potable water to be used to flush the Equalization Tank and its associated Jet Mix System at the end of a Relief Event. The flow tube will be located below ground in a underground valve/flow meter vault. The magmeter transmitter shall be located above ground mounted 4 foot 6 inches off the ground to provide local flow indication. The local control station for each of the motorized Flushing Water Valves FCV-511 thru FCV-518 should be located close to this magmeter to permit manually flushing of the Tank if required. The flow transmitter output shall be wired to the PLC local control panel in the Equalization Facility Electrical Building for monitoring and control. High and Low absolute alarms shall be confirmed (initially set to 80% and 20% level respectively).

B. Equalization Tank Flushing Water Valve Control – FCV-511/512/513/514/515/516/517/518 (P&ID I-108): A motorized open/close valve shall be provided for each of the eight (8) flushing zones associated with cleaning out the debris and remaining wastewater left inside the Equalization Tank after a Relief Event. When a Relief Event has ended and the Equalization and Jet Mixing System has drained back by gravity to the South Fork Peachtree Creek Trunk Sewer, the Plant Control System shall initiate a Equalization Flushing Sequence. The Plant Control System shall confirm that Diversion Pump are not pumping wastewater to the Equalization (all pumps are shutdown) and the Equalization tank level is at its minimum level (may not be

completely empty when gravity flow stops) and there is no flow thru the Flow Return pump discharge magmeters FE/FIT-531/532/533 and the EQ Tank drainage pumps have completed their drainage operation When it is confirmed that the Equalization Tank is out of service – the Equalization Tank Automatic Flushing Sequence can be initiated. The Plant Control System shall provide an indication that Equalization Tank is now out of service and requesting permission from the operator to enter into a return to stand-by service Automatic Flushing Sequence. There will be a selector switch to allow the operator to manual initiate the flushing sequence or for it to automatically start at the end of the Flow Return operation. The operator will also be able to interrupt the flushing operation at any time prior to its completion. When initiated the Equalization Tank Automatic Flushing Sequence shall sequentially operate each of the motorized flushing water control valves in sequential fashion. Each valve will be fully opened and the flow rate on the non-portable water magmeter FE/FIT-510 confirmed to be greater than the minimum flushing water flow rate (initially set at 750 GPM per open zone flushing valve). When the flushing flow rate has been confirmed, a zone flushing timer shall be started. The open flushing water valve shall remain open for an adjustable period of time (initially set at one minute). The timer shall held at its current elapsed time any time that the observed flow rate drops beyond the flushing water set point mentioned previously. When the zone flushing period has expired, the next flushing water valve shall be opened and the current valve closed. The Plant Control System shall both monitor and control the position of the motorized open/close valves. Discrete Inputs and Outputs shall be configured as shown in the I/O List. A High Priority Alarm shall be generated if a motorized valve fails to open or close when commanded to operate or when the Flow Rate as measured by FE/FIT-510 drops below the flushing water flow set point (initially set at 750 GPM per open zone flushing valve) during the period of time that the associated valve is opened for flushing of its zone of the Equalization Tank interior. A high priority alarm shall be generated any time these valves are not enabled for Remote Control (Local/Remote valve status input). Note that during the EQ Tank Flushing Sequence, the EQ Tank drainage pumps will be started (after a pre-set but adjustable time delay to allow the water to reach the pump suction) and will operate continuous to pump the flushing water and collected debris back to the South Forks Peachtree Creek Trunk sewer.

C. Non-Potable Water to Equalization Tank Flushing Water Header Motorized Isolation Valve FCV-519 (P&ID I-108): The Plant Control System shall both monitor and control the position of the motorized open/close valve FCV-519 that controls flow from the non-potable water supply to the Equalization Tank Flushing Water Magmeter and Flushing water header isolation valves FCV-511 thru FCV-518. The isolation valve is normally closed (has a build-in battery pack to insure that the valve closes or stays closed on loss of 208 VAC power feed to the valve actuator) but opens when EQ Tank Automatic Flushing Sequence is initiated. Discrete Inputs and Outputs shall be configured as shown in the I/O List. Note this motorized valve can be locally operated by the plant operations staff (there is a remote status input to warn when the valve cannot be control by the Plant Control System). Failure of the motorized valve to travel in an appropriate time (adjustable timer initially set to 2 minutes) shall generate a high priority alarm. A high priority alarm shall be generated any time this valve is not enabled for Remote Control (Local/Remote valve status input).

2.07 ODOR CONTROL LOGIC

A. Diversion Wet Well Odor Control Scrubber - Loop 401 (P&ID I-106): A vendor furnished NEMA 4X local control panel OCP-401 shall be provided with the Odor Control System and shall be located local to the Odor Control Scrubber (must at least 3 feet away from all Odor ControL Equipment and ducts). All controls for the Odor Control system will be located within this panel. The Plant Control System shall receive a discrete input from this panel for remote

common trouble alarming and shall monitor status (running, common trouble, H-O-A Selector Switch in Auto) and enable the operation of the Odor Control Fan per the logic noted below.

B. Diversion Wet Well Odor Control Operation - Loop 401 (P&ID I-106): The Odor Control System consists of a Dry Media Bed Scrubber and a Fan F-401 to pull foul air from the both Diversion Wet Wells thru the Scrubber media. The plant control system shall start and stop and monitor running and trouble status of this Fan to enable operation of the Odor Control System. Like the Diversion Facility itself, the Odor Control System will normally be left in a passive standby mode. However, when the Diversion Facility enters its Wet Weather Operation/Relief Event Operating Mode and wastewater is allowed to diverted to the Diversion Wet Wells, the Plant Control System shall start the Fan Motor F-401 which will continue to run until the Diversion Facility enters its Dry Weather Flow/Maintenance Mode and will continue operating for an Operator adjustable period of time (initially set for 92 hours – 4 days) after the Wet Well has been emptied and the Diversion Facility has returned to its normal offline mode. Once this adjustable timer has expired the fan motor will be turn off and the Wet Well Odor Control System will be offline and in standby until another Relief event occurs. The Odor Control System will not run when Diversion Facility is only operating in its Dry Weather Maintenance Mode. The Odor Control System shall be disabled on Diversion Facility Fire Detection Loop 199.

C. Diversion Facility Valve Room Loss of Ventilation Alarming System Loop 415 (P&ID I-106): At thermal air flow switch FSL-415 shall be mounted in the discharge duct from Exhaust Fans EF-301 and EF-302 (100% redundant capacity) to monitor the ventilation air flow from the Diversion Facility Valve Room. At least 6 Air Changes per Hour is required by NFPA 820 to lower the classification of the Valve Room from Class 1 Division 2 to unclassified. Per NFPA 820 (2003 Edition) Article 7.5.2/3 Local and Remote alarms are required to be provided in case of Ventilation System failure. A discrete contact from the low air flow switch shall be wired to the Loss of Ventilation Alarming System located inside the Diversion Facility PLC Cabinet where relays shall activate local audible and visual alarms inside the ventilated area and at all ingress/egress points. The loss of ventilation alarming relays will also generated a contact output on low air flow to be wired to the Plant Control System for Remote Alarming. The low air flow switch input to the Diversion Facility PLC Local Control Panel shall generate a high priority alarm when detected (open to alarm on low air flow). Additionally a switch contact from the Diversion Wet Well Gas Monitoring Panels for Wet Wells #1 and 2 (ASH-210 and ASH-310) shall be wired to the Loss of Ventilation Alarming System to activate the horns and lights on high combustible gas detection (in addition to the alarming on loss of ventilation air flow).

D. Diversion Facility Odor Control Combustible Gas Detection - Loops 410/411/412/413 (P&ID I-106): A Combustible Gas Detector AIT-411 shall be provided for the Diversion Facility Odor Control System OC-401 and will be local to the Odor Control Scrubber. Combustible Gas Detection will be monitored via Infrared Absorption type Sensor located next to the Odor Scrubber. Per NFPA 820, local and remote alarming of combustible gas detection shall be provided. Detection of High Combustible Gas Level by the Plant Control System shall generate a high priority alarm. Additional, Hydrogen Sulphide Gas Detectors shall be provided for the Inlet, after the filter bed, and on the scrubber outlet of the Odor Control Scrubber OC-401 (AIT-410 Inlet, AIT-413 after filter bed, and AIT-412 Outlet). These analyzers shall be furnished with sampling systems and shall be part of a new Gas Monitoring Panel OCGMP-410 to be located at the Scrubber which shall provide the local alarming function as well as house the analyzer transmitters and sampling systems. Loss of sampling flow/sampling system failure signal from each Sampling system shall be wired to the Plant Control System for generating a high priority alarm. The analyzers themselves will also be wired to the Plant Control System for monitoring and alarming. High Hydrogen Sulphide Gas Detection after the filter bed of the Scrubber shall

generate an high priority alarm to warn the operator that it may be time to change the media in the Scrubber. This alarm shall be latched and must be manually reset by the operator.

E. Equalization Facility Odor Control Scrubber - Loop 501 (P&ID I-107): A vendor furnished NEMA 4X local control panel OCP-501 shall be provided with the Odor Control System and shall be located local to the Odor Control Scrubber (must at least 3 feet away from all Odor ControL Equipment and ducts). All controls for the Odor Control system will be located within this panel. The Plant Control System shall receive a discrete input from this panel for remote common trouble alarming and shall monitor status (running, common trouble, H-O-A Selector Switch in Auto) and enable the operation of the Odor Control Fan per the logic noted below.

F. Equalization Facility Odor Control Operation - Loop 501 (P&ID I-107): The Odor Control System consists of a Dry Media Bed Scrubber and a Fan F-501 to pull foul air from the both Diversion Wet Wells thru the Scrubber media. The plant control system shall start and stop and monitor running and trouble status of this Fan to enable operation of the Odor Control System. Like the Equalization Facility itself, the Odor Control System will normally be left in a passive standby mode. However, when the Equalization Facility enters its Wet Weather Operation/Relief Event Operating Mode and wastewater is pumped fromDiversion Wet Wells to the Cheshire Bridge Junction Chamber, where it flows by Gravity to the Equalization Tank, the Plant Control System shall start the Fan Motor F-501 which will continue to run until the Equalization Facility enters its Dry Weather Flow/Maintenance Mode and will continue operating for an Operator adjustable period of time (initially set for 92 hours – 4 days) after the Equalization Tankhas been emptied and the Equalization Facility has returned to its normal offline mode. Once this adjustable timer has expired the fan motor will be turn off and the Wet Well Odor Control System will be offline and in standby until another Relief event occurs. The Odor Control System will not run when Equalization Facility is only operating in its Dry Weather Maintenance Mode. The Odor Control System shall be disabled on Equalization Facility Fire Detection Loop 599..

G. Equalization Facility Jet Mix Pump Room Loss of Ventilation Alarming System Loop 515 (P&ID I-107): Redundant thermal air flow switches FSL-515A/B shall monitor the ventilation air flow to the Equalization Facility Jet Mix Pump Room produced by the Exhaust Fans EF-701 and EF-702 (100% Redundant Capacity). At least 6 Air Changes per Hour is required by NFPA 820 to lower the classification of the Jet Mix Pump Room from Class 1 Division 2 to unclassified. Per NFPA 820 (2003 Edition) Article 7.5.2/3 Local and Remote alarms are required to be provided in case of Ventilation System failure. A discrete contact from each low air flow switch shall be wired to the Loss of Ventilation Alarming System located inside the Diversion Facility PLC Cabinet where relays shall activate local audible and visual alarms inside the ventilated area and at all ingress/egress points The loss of ventilation panel will also generated a contact output on low air flow to be wired to the Plant Control System for Remote Alarming. The low air flow switch input to the Equalization Facility PLC Local Control Panel shall generate a high priority alarm when detected (open to alarm on low air flow).

H. Equalization Facility Odor Control Combustible Gas Detection - Loops 510, 511, 512, 513 (P&ID I-107): A Combustible Gas Detector AIT-511 shall be provided for the Equalization Facility Odor Control System OC-501 and will be local to the Odor Control Scrubber. Combustible Gas Detection will be monitored via Infrared Absorption type Sensor located next to the Odor Scrubber. Per NFPA 820, local and remote alarming of combustible gas detection shall be provided. Detection of High Combustible Gas Level by the Plant Control System shall generate a high priority alarm. Additional, Hydrogen Sulphide Gas Detectors shall be provided for the Inlet, after the filter bed, and on the scrubber outlet of the Odor Control Scrubber OC-501 (AIT-510 Inlet, AIT-513 after filter bed, and AIT-512 Outlet). These analyzers shall be furnished

with sampling systems and shall be part of a new Gas Monitoring Panel OCGMP-5410 to be located at the Scrubber which shall provide the local alarming function as well as house the analyzer transmitters and sampling systems. Loss of sampling flow/sampling system failure signal from each Sampling system shall be wired to the Plant Control System for generating a high priority alarm. The analyzers themselves will also be wired to the Plant Control System for monitoring and alarming. High Hydrogen Sulphide Gas Detection after the filter bed of the Scrubber shall generate an high priority alarm to warn the operator that it may be time to change the media in the Scrubber. This alarm shall be latched and must be manually reset by the operator.

2.08 MISCELLANEOUS

A. Fire Alarm Panel –- Loop 199 (P&ID I-101) - Reference Electrical Drawing E3-103 and Fire Alarm System Riser Drawing E0-603: In accordance with NFPA 820, the Diversion Facility shall be monitored for fire detection via a new fire alarm panel located in the Diversion Facility Electrical Building that will be able to be remotely monitored via a telephone connection. The fire alarm system will be configured with a duplex telephone dialer. There will be a common trouble alarm wired from the Fire Alarm Panel to the plant control system for remote alarming logging.

B. Fire Alarm Panel –- Loop 599 (P&ID I-104) - Reference Electrical Drawing E7-103 and Fire Alarm System Riser Drawing E0-603: In accordance with NFPA 820, the Equalization Facility shall be monitored for fire detection via a new fire alarm panel located in the Equalization Facility Electrical Building that will be able to be remotely monitored via a telephone connection. The fire alarm system will be configured with a duplex telephone dialer. There will be a common trouble alarm wired from the Fire Alarm Panel to the plant control system for remote alarming logging.

C. Bridge Crane BCO-101– Diversion Wet Well - Reference Electrical Power Plan Drawing E3-103 and Electrical Single Line Drawing E3-101: There will be a Bridge Crane installed above the submersible pumps in the Diversion Wet Well Area. All control of the Bridge Crane motor(s) shall be local only.

D. Bridge Crane BCO-102 – Diversion Pump Station Valve Room - Reference Electrical Power Plan Drawing E3-103 and Electrical Single Line Drawing E3-101: There will be a Bridge Crane installed in the Diversion Valve Room. All control of the Bridge Crane motor(s) shall be local only.

E. Bridge Crane BCO-104 – Equalization Facility - Reference Electrical Power Plan Drawing E7-102 and Electrical Single Line Drawing E7-101: There will be a Monorail installed above the Jet Mixing Pumps in the Equalization Facility. All control of the Bridge Crane motor(s) shall be local only.

F. Monorail BCO-103 – Equalization Facility - Reference Electrical Power Plan Drawing E7-102 and Electrical Single Line Drawing E3-101: There will be a Monorail installed above the Jet Mixing Pumps in the Equalization Facility. All control of the Monorail motor(s) shall be local only.

END OF SECTION 13150

SECTION 13200
CONTROL PANELS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The provisions and requirements of Division 13, Section 13000 "General Provisions" of this Specification shall apply to the work specified in this section.

C. Components associated with the furnishing and fabricating of control panels associated with this Specification shall be as specified in Division 13, Section 13250 "Control Panel Components" or as specified in Division 13, Section 13300 "Instrumentation Specifications" for panel mounted instruments (electronic controllers, signal conditioners, panel meters/indicators, etc.)

D. Control Panels and/or other Cabinets furnished under this Specification shall provide transient surge and lightning protection as required in Division 13 Contract Specification 13270 "Surge and Lightning Protection".

1.02 SUMMARY

A. This Section covers the furnishing of new or reworking of existing control panels and/or Control System or Telemetry System Processor or I/O Cabinets associated with instrumentation and control system that are not provided under other sections of the Contract and as necessary to complete the instrumentation and controls as shown on the Contract Drawings and Contract Specifications.

B. Panel(s) shall be fabricated; instruments installed, and wired in the manufacturer's factory. Wiring shall be completed and tested prior to shipment. External connections shall be by way of numbered terminal blocks.

C. Furnish all labor, supervision, materials, equipment and incidentals required to complete and ready for operation, said control panels and/or cabinets as depicted on the Contract Drawings or on the P&IDs or on any Instrumentation Details provided. Where required this shall include reworking existing control panel(s) to add or eliminate functionality as shown on the Contract Documents. Unless otherwise noted, the installation of all control panels or other cabinets furnished under this Specification shall be performed by the General Contractor and/or Electrical Contractor. The party responsible for the design and fabrication of all new or reworked control panels and cabinets (Instrumentation and Controls Subcontractor or Telemetry System Subcontractor) shall be responsible to certify the proper installation and operation of all supplied equipment.

All the Work in this Section shall be the sole responsibility of the designer of the associated system (Instrumentation and Controls Subcontractor or Telemetry System Subcontractor). Components and enclosures may be provided to the appropriate Subcontractor by other suppliers and/or manufacturers, but the packaging, wiring and testing of these components and the production of the final product shall conform to this specification and shall be the sole

responsibility of the appropriate designer (Instrumentation and Controls Subcontractor or Telemetry System Subcontractor if separate entities).

D. The control panels shall be provided under this Section shall include those panels listed in the attached Table of Required Control Panels.

1.03 REFERENCE STANDARDS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Reference Standards" and as specified herein.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Quality Assurance" and as specified herein.

1.05 SUBMITTALS

A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. In accordance with the General Conditions and the Special Conditions of the Contract and with Contract Specification 13000, submit to the Engineer the following documentation to demonstration compliance with submittal requirements of the Contract:

C. Control Panel Engineering Submittal: The Contractor shall submit a control panel engineering submittal for each control panel and enclosure provided and/or existing control panel to be reworked. The submittal shall completely define and document the construction, finish, layout, power circuits, signal and safety grounding circuits, fuses, circuit breakers, signal circuits, internally mounted instrumentation and SCADA/Telemetry system components, face plate mounted instrumentation components, internal panel arrangements, and external panel arrangements. All panel drawings shall be "B" size, and all data sheets and manufacturer specification sheets shall be "A" size. The submittal shall be in conformance with NEMA Standard ICS-1-1.01, shall be submitted as a singular complete bound volume or multi-volume package and shall have the following content:

1. List of all new Control Panels and I/O Cabinets and/or new sub-panels associated with existing Control Panels to be furnished.
2. A complete index shall appear in the front of each bound volume. Panels shall be indexed by system or process area, and drawings and data associated with a panel shall be grouped

together. All panel tagging and nameplate nomenclature shall be consistent with the requirements of the Contract Documents.

3. Definition of all rework to be performed on existing control panels and I/O Cabinets including panel name, location, and general description of work to be done in each panel or cabinet.

4. General Arrangement (GA) drawing(s) of all control panels and I/O Cabinets. GAs shall include outline, dimensions, and estimated weight for each panel or cabinet. Drawings shall denote the physical location of all panel ingress and egress points.

5. Complete Identified Bill of Materials for each control panel or cabinet. Bill of Materials shall reference General Arrangement drawing(s) and shall include ID#, manufacturer, model number, description, and quantity for each item.

6. Complete Identified list of nameplates and annunicator windows associated with each panel or cabinet. Include ID#, tag number, and service description (engraving inscription). These shall be cross-referenced to the GA Drawings.

7. Project specific identified product data sheets for each component in the Bill(s) of Materials.

8. Interconnect wiring drawings for all internal panel or cabinet wiring. Interconnect drawings shall identify all terminal strips, wiring, and devices located inside the panel and shall note where external connections shall be made. External connections shall be denoted with a description and tag number, where available.

9. Where available, provide manufacturer instruction manuals containing manufacturer installation and maintenance requirements and troubleshooting guide.

10. Complete list of Spare Parts, Expendables, and Test Equipment to be provided in accordance with Specification 13000 and General Conditions section of the Contract. If not included in the Subcontractor's bid, complete pricing for all recommended Spare Parts, Expendables, Special Tools, etc that are recommended but not specifically included shall be furnished.

D. After Fabrication, Installation, and Testing are complete and approved, submit Record Documents per Contract Specification 13000 Section "Record Drawings".

E. After Record Drawings have been approved, submit Operation and Maintenance Manuals per Contract Specification 13000 Section "Operation and Maintenance Manuals".

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Identification, Storage and Handling of all supplied control panels and cabinets shall be in full conformance with the Contract Specifications and with Division 13 Contract Specification 13000 Section "Delivery, Storage, and Handling" and as specified herein.

B. Control Panels and Cabinets shall be mounted on wooden skids at least four inches high suitable for movement via forklift truck. Control Panels and Cabinets shall be suitably wrapped or crated depending on the distance to be traveled and the amount of transfers to be made during shipment from point of origin to point of actual installation.

C. Control Panels and Cabinets shall be only shipped via Air-Ride Van.

D. Control Panels and Cabinets shall not be stored out-of-doors even if designed for outdoor installation until temporary or permanent sun and rain shields have been erected at the installation or storage location (assuming the enclosure is rating for outdoor installation).

E. Instruments and control devices inside control panels or cabinets shall be "blocked" and "tied off" to prevent damage during shipment. Front of panel instruments shall be removed and re-packed in their original containers for shipment. Similarly, all Control System processors, I/O Cards, and other sensitive electronic equipment shall be removed and re-packed in their original containers for shipment. All removed instruments and controls shall be properly labeled to facilitate re-assembly at the jobsite.

F. All mounting hardware, accessories, and at least one set of drawings and instruction manuals necessary to complete the field installation shall be shipped with the Control Panel/Cabinet Shipment.

1.07 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passing through such restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.08 WARRANTY

A. Provide a warranty for all instrumentation and controls in accordance with the general requirements of the Contract Specifications. Unless specified more stringently elsewhere in the general requirements, the components of the instrumentation and controls system shall be warranted against defective materials, design, and workmanship for a period of one (1) year from the date of final acceptance.

B. During the warranty period, the Supplier shall furnish personnel to inspect, test, and take corrective action to correct all deficiencies in his "Scope of Work" such that the corrective action is consistent with the quality of materials and work of the original construction and is in conformance with the Contract Specifications, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Furnish, fabricate, test, and make ready for operation the control panels and cabinets required to complete the Instrumentation and Controls design per the Contract Specifications including Contract Specification 13000 "Instrumentation and Controls – General Provisions" and as shown on the Contract Drawings.

B. Unless otherwise specified on the Contract Drawings, all control panels and cabinets shall be of the fully enclosed type suitable for the mounting of the instrumentation and control devices as listed in the Contract Specifications and as shown on the Contract drawings.

C. All control panel and cabinets shall be fully lockable with a lock installed in the door handle or by padlocking using a hasp and staple for padlocking. Locks for each panel or cabinet provided under this Contract shall be keyed alike.

D. All panel components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates, in such a manner that the component may be removed without removing the plate, and shall not be directly mounted to the enclosure. Mounting shall be rigid and stable unless shock mounting is required

otherwise by the manufacturer to protect equipment from vibration. Mounting orientation shall be in accordance with the requirements of each component.

E. Front of panel devices (indicating lights, pushbuttons, selector switches, etc.) shall be grouped together by associated equipment/function. Layout of the control devices shall be in accordance with the sequence of operations proceeding from left to right across the front of the control panel.

F. The instruments designated for rear-of-panel mounting shall be arranged within the panel in a manner to allow for ease of maintenance and adjustment.

G. Instruments to be mounted inside panels that require rear access for wiring, calibration, or testing and that can not be surface mounted on interior back plates while still providing access to all wiring (even if pre-wired to external terminal strips), calibration or testing functions shall be mounted on swing-out sub-panels to facilitate such maintenance, troubleshooting, or testing activities without requiring one to physically stand inside the panel.

H. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc. required to maintain the NEMA rating of the panel.

I. Front of panel instruments that are more than 6 inches deep, weight more than 10 pounds, or exert more than 4 ft-lb moment force on the face of the panel shall be supported underneath by at least 1 inch x 1/8 inch thick steel angle to prevent wrapping or damage to the panel and/or instrument. Front of panel instruments shall be design to be flush or semi-flush mounted.

J. Conductors running from the field to the panels shall be continuous without splices, except at approved junction boxes. The junction boxes shall have terminal blocks with at least 20 percent spare terminals. Special care shall be exercised to pass all grounding and shield conductors through such junction boxes with the least possible resistance. Conduit and cables entering panels shall be sealed to prevent the intrusion of gases or moisture.

K. The internal framework of each panel shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging and lifting of the control panels during installation. Plugs shall be provided and shall unobtrusively fill the panel lifting ring holes when substituted for the lifting rings after installation is complete. The control panel framework and instrument supports associated with each Control Panels shall be designed in accordance with the Seismic Zone associated with the project as noted in the Contract Drawings.

L. Each control panel or cabinet shall be provided with exterior nameplate that identifies the panel in accordance with the panel name and description as shown on the Contract Drawings. Nameplates shall be at least 1-inch high x 3-inch wide constructed of plastic laminate that is at least 1/16 inch

(1.6 mm) thickness for nameplates up to 20 square inch (129 square cm) or at least 1/8 inch thick (3.2 mm) for larger sizes. Nameplate shall be engraved using a "sans serif" type font like Arial or Helvetica typefaces. Lettering shall be approximately ¼" in height, consisting of Black Lettering on a White background. Nameplates shall be beveled and attached to panels by self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers. Nameplates that are only adhesive bonded or glued to the panel or cabinet shall not be accepted.

M. Additionally each control panel or cabinet shall be provided with nameplates identifying each major component including relays, timers, signal conditioners, power supplies, terminal strips, circuit breakers, fuse assembly, selector switches, pilot lights, etc. Nameplates shall be laminated plastic, engraved white letters with a black background. Nameplates shall be mounted adjacent to but not on each component and shall be clearly visible. Nameplates shall be permanently affixed with stainless steel self-tapping screws.

N. Where applicable, also provide a nameplate, which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Engraving shall be approximately 3/16" in height, consisting of black lettering on a high visibility yellow background. Nameplates shall be beveled and attached to panels by self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers. Adhesive bonded or glued on nameplates shall not be accepted.

O. Control Panels containing Programmable Logic Controllers or programmable relays or programmable instruments (ie electronic controllers, etc.) shall be provided with a fold-down shelf where a laptop computer can be placed when troubleshooting or reprogramming devices inside the control panel. The shelf can be internal or external to the control panel. From the fold-down shelf, there will be convenient access to plug-in programming input ports on the device and a 120VAC convenient outlet for powering the laptop. For PLC or DCS Processors or Remote I/O Cabinets, programming ports shall include the ability for the laptop to connect to the PLC or DCS Communication Data Highway(s). If there is not convenient access to connections for programming – additional plug-in programming connections shall be installed local to the fold-down shelf. Shelves that are external to a furnished Control Panels shall be attached to the front of the Control panel and shall provide for this access to AC power and programming/troubleshooting port(s) without having to open up the control panel.

2.02 PANEL MATERIALS AND CONSTRUCTION

A. General Requirements

1. Unless otherwise specified, all panels located in indoor non-hazardous, non-process areas shall be of NEMA 12 construction and shall be labeled by Underwriters Laboratories. Freestanding panels shall be constructed of 14 gauge or thicker sheet steel, suitably braced internally for structural rigidity and strength. Stainless steel shall be substituted where specified in the Drawings. Wall or Unistrut mounted panels shall be 16 gauge or better steel. All exposed welds, seams, or edges shall be ground smooth. Front panels or panels containing instruments shall be 14 gauge or thicker sheet steel, reinforced to prevent warping or distortion. All doors shall be lockable, mounted with strong, continuous, piano type hinges and be provided with door handles and three point latches, or screw clamps.

2. All panels located in non-hazardous, outdoor areas or in indoor process areas, and where specified in the Contract Documents, shall be of NEMA 4X construction and shall be labeled by Underwriters Laboratories.

a. Except where indicated otherwise in Contract Documents, wall or Unistrut mounted panels shall be constructed of fiberglass-reinforced polyester (FRP) material with a minimum wall thickness of 0.19 inches, reinforced on top, bottom and sides with epoxy painted steel, fiberglass hinges, and stainless steel captivated door screws. Interior panels of 14 gauge or thicker steel construction shall be provided where necessary for instrument mounting.

b. Freestanding panels, and all those specified as stainless steel in the Drawings, shall be constructed of 316 Stainless Steel. Minimum thickness shall be 14 gauge for freestanding panels, 16 gauge for wall or Unistrut mounted panels. Continuous door hinge, hinge pin, door clamps, hasp and staple for padlocking, shall be of stainless steel construction. Interior panels of 14 gauge or thicker steel construction shall be provided where necessary for instrument mounting.

3. Provide explosion-proof enclosures where required in hazardous areas.

4. Panels shall be provided with full length, fully gasketed rear doors or front access doors as shown on the panel details. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments. For freestanding panels, full length rear access door shall be not greater than 36 inches in width. All doors shall open a minimum of 90 degrees.

5. The panel shall be suitable for top or bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry the panel top shall be provided with nominal one foot square removable access plates which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, or other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.

B. Finish Requirements

1. All sections shall be descaled, degreased, filled, ground and finished. The enclosure, when fabricated of carbon steel, shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels will not require a paint finish.

2. The panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.

3. Immediately after cleaning, one coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and topcoat of two-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.

4. All FRP panels located in direct sunlight shall be provided with a UV protective coating to prevent discoloration and cracking.

5. Apply a minimum of two coats of flat white lacquer on the panel interior after priming.

6. Unless otherwise noted, the finish exterior colors to be used shall be selected by the Owner from color clips supplied by the System Supplier.

C. Manufacturer

1. Except for DCS equipment, all panels shall be by Hoffman, ITS Enclosures, Rittal, or approved equal.

2. Unless otherwise noted on the Contract Drawings, Vendor standard cabinets shall be provided for DCS Control Systems, where applicable.

2.03 TEMPERATURE CONTROL

A. Freestanding panels shall be provided with louvers and/or forced air ventilation as required to prevent temperature buildup due to electrical devices mounted in or on the panel.

B. Except for panels mounted with their backs directly adjacent to a wall, louvers shall be in the rear of the panels, top and bottom, and shall be stamped sheet metal construction.

C. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides.

D. Forced air ventilation fans, where used, shall provide a positive internal pressure within the panel and shall be provided with washable or replaceable filters. Fan motors shall operate on 120-volt, 60-Hz power.

E. Should sufficient heat be generated within a panel where dissipation cannot be adequately accomplished with natural convection or forced air ventilation, a heat exchanger or air conditioner shall be provided. Air conditioners that require cooling water supply shall only be provided where approved by Engineer. Pneumatic panel coolers shall only be supplied where sufficient excess instrument quality air is available and only then when approved by Engineer.

F. Control panels that are exposed to sunlight shall be equipped with adequate sunshields. The sunshield shall consist of one or more pieces of stainless steel, FRP, or other suitable material of sufficient size to cover the top, sides, and rear of the panel (where applicable), and to hang over the front of the panel to shade any instruments mounted there. Sunshield pieces shall be secured to the panel by bolts and shall have no less than 1 inch of clearance from the panel and from one another, to allow for air circulation over the sunshield surfaces and access to panel door(s).

G. The internal temperature of all panels shall be regulated so as not to exceed 100 degrees Fahrenheit. Under no circumstances shall the panel cooling equipment compromise the NEMA rating of the panel.

H. Control panels and Cabinets to be located in areas where the air temperature inside the enclosure can go below the dew point shall be provided with thermostatically (adjustable) controlled heaters to prevent moisture formation inside the enclosure.

2.04 CORROSION CONTROL

A. Control panels or cabinets shall be protected from internal corrosion by the use of corrosion-inhibiting vapor capsules as manufactured by Hoffman Engineering Model A-HCI; or approved equal.

2.05 INTERNAL CONSTRUCTION

A. Internal Electrical Wiring

1. The completed control panel or I/O cabinet assembly shall be UL certified per UL 508 (non-hazardous locations) or UL 698 (class 1 division 2 hazardous locations).

2. Panel equipment shall be mounted and wired on or within the cabinet. Wiring shall comply with the National Electrical Code. Wiring within the panel shall be grouped together with harnesses or ducts and secured to the structure. All internal panel wiring shall be shown on interconnect type-wiring drawings utilizing symbology that is compatible with ISA Standard S5.4 "Instrument Loop Diagrams". Wiring drawings shall show all internal panel AC and DC power distribution and control signal wiring and shall clearly note all external field connections. All panel wiring shall be identified and numbered in compliance with the numbering system shown on the wiring / interconnection diagrams. All panel general arrangement, wiring, and interconnection diagrams shall be submitted by the supplier as part of the Shop Drawings for review by the Engineer.

3. All panel wiring shall comply with the Transient Surge and Lightning Protection requirements of the Contract Drawings and Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions" and Division 13 Contract Specification 13270 – "Surge and Lightning Protection".

4. AC Power (and AC discrete signal wiring) and low voltage DC signal wiring shall be routed in separate wire ways. Crossing of the AC and low voltage DC signal wiring shall be at right angles.

5. AC Power and discrete signal wiring shall be stranded copper, minimum size #14 AWG (except for shielded instrumentation cable), with 600 volt, 90 degree C, flame retardant, Type MTW thermoplastic insulation.

6. Panel Graphic light or annunicator wiring (24 volt maximum) may be 16 AWG if properly fuse protected and terminated in a terminal block capable of accepting No. 14 AWG field wiring.

7. Analog signal wiring shall be single pair 16 gauge stranded copper conductors, PVC insulated, PVC jacket, 600 Volt, 75/90 degrees Celsius rated, 100 percent aluminum-Mylar shield with drain wire, NEC Tray Cable; Belden 9342 or equal.

8. Panel wiring colors shall be as follows:
   a. AC Power Supply – Line or Hot – BLACK – Wire Label Suffix L
   b. AC Power Supply – Neutral or Common – WHITE - Wire Label Suffix N
   c. AC Power Supply – Ground – GREEN - Wire Label Suffix PG
   d. AC/DC Discrete Control Signals – RED - Wire Label Suffix C [Non Isolated Digital Outputs 120 VAC or 24 VDC hot leg (PLC Panel Feeds Power) or Non Isolated Digital Inputs 120 VAC or 24 VDC hot leg going to the field (PLC Panel Feeds Power)]
   e. AC/DC Discrete Control Signals – BLUE - Wire Label Suffix C [Non Isolated Digital Outputs 120 VAC or 24 VDC switched leg (PLC Panel Feeds Power)]
   f. AC/DC Discrete Control Signals – ORANGE - Wire Label Suffix C [Isolated Digital Outputs 120 VAC or 24 VDC hot leg (Field Device Feeds Power)]
   g. AC/DC Discrete Control Signals – PURPLE - Wire Label Suffix C [Isolated Digital Outputs 120 VAC or 24 VDC return or neutral (Field Device Supplies Return)]
   h. AC/DC Discrete Control Signals – YELLOW - Wire Label Suffix C [Non Isolated Digital Inputs 120 VAC or 24 VDC switched leg (PLC Panel Feeds Power) or Isolated Digital Inputs 120 VAC or 24 VDC hot leg (Field Device Feeds Power)]

i. AC/DC Discrete Control Signals – WHITE - Wire Label Suffix C [Non Isolated Digital Inputs 120 VAC or 24 VDC neutral or common (PLC Panel Feeds Power)]

j. AC/DC Discrete Control Signals – GREY - Wire Label Suffix C [Isolated Digital Inputs 120 VAC or 24 VDC return or neutral (Field Device Supplies Return)]

k. Analog Control Signals – Positive – WHITE or CLEAR - Wire Label Suffix C

l. Analog Control Signals – Negative – BLACK - Wire Label Suffix C

m. Equipment or Chassis Ground – GREEN - Wire Label Suffix PG

n. Discrete Control Signals that are externally powered – YELLOW

9. Externally connections for AC Power supply and Field wiring shall be connected thru the use of terminal blocks mounted inside the enclosure. Each enclosure shall be provided with a minimum of 20 percent spares terminals.

10. Terminal blocks shall be arranged in vertical rows and separated into groups (AC Power, AC control, DC control, Analog signal, and alarm). Each terminal strip shall be individually labeled and the associated terminal blocks numbered in numerical order from top to bottom.

11. Terminal blocks shall be IEC style, screw clamp type, single height feed through style terminal blocks rated for the appropriate voltage level (300V minimum) similar to Allen Bradley model 1492-W4 or approved equal. Double and Triple Height terminal can be used for internal panel distribution but should be avoided for field terminations unless as approved by Owner or Engineer. Terminal Blocks used for termination of grounds (including instrument shield grounds) shall be green/yellow stripped similar to Allen Bradley model 1492-WG4 or approved equal. Fused terminal blocks shall be provided with LED type blown fused indicators, similar to Allen Bradley model 1492-H5 or approved equal. High current terminal blocks to be NEMA Open Construction style terminal blocks similar to Allen Bradley 1492-CA1 or CE2 or approved equal.

12. Wiring trough for supporting internal wiring shall be plastic type with snap on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the sub panel by using stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.

13. Each wire shall be provided with a pre-typed identification markers at both ends and the numbering shall be in accordance with the wiring drawings.

14. Wiring troughs shall not be filled to more than 60 percent visible fill. Wiring trough covers shall be match marked to identify placement. If component identification is shown on covers for visibility, the ID shall also appear on the mounting sub-panel.

15. Each panel shall have a single tube, fluorescent light fixture, 20 Watt in size, mounted internally to the ceiling of the panel. Light fixture shall be switched and individually circuit breaker protected.

16. Each panel shall have a specification grade duplex GFI protected convenience receptacle mounted internally within a stamped steel device box with appropriate cover. The convenience outlet shall be individually protected by a circuit breaker.

17. A lamp test push button shall be provided on the front of each control panel to test all the indicator lamps bulbs at the same time.

18. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.

19. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.

20. Each panel, where applicable, shall be provided with analog signal isolation (I/I) where analog signals are sent from one panel or cabinet to another.

21. Each panel shall be provided with an incoming AC power circuit breaker. AC powered individual instruments and controls shall be individual fused protected.

22. All wiring to hand switches and the like which are live circuits independent of the panel's normal circuit breaker protection shall be clearly identified as such.

23. Panels shall have an initial installed capacity of I/O points as shown on drawings and as described in the specification sections plus 25 percent installed spares and capacity for 20 percent input/output expansion within the enclosures provided.

24. Provide interposing heavy duty interposing relays for start/stop control of Size 4 and larger motor starters.

B. Pneumatic Tubing: Pneumatic tubing shall be a minimum of 1/4-in O.D manufactured from copper; PVC coated copper; or 316 stainless steel as noted on Contract Drawings and interconnected with compression type fittings. All tubing shall be rigidly supported and run in horizontal or vertical planes. All pneumatic equipment shall be provided with separate shut-off valves. Flexible polyethylene tubing shall be used on all devices mounted on hinged doors, etc. A screened vent shall be provided on all enclosures using pneumatic instruments.

C. Print Storage Pockets: Print storage pockets shall be provided on the inside of each panel. Its size shall be sufficient to hold all of the prints required to service the equipment.

2.06 MAINTENANCE REQUIREMENTS

A. Maintenance Requirements of all supplied control panels and cabinets shall be in full conformance with the Contract Specifications and with Division 13 Contract Specification 13000 Section "Maintenance Requirements" and as specified herein.

B. Spare Parts: In addition to any spare parts required by the related contract specification sections, Provide the following spare parts where the associated item is included in the design of the control panel or cabinet being furnished under this specification:

1. All spare parts shall be new and unused.

2. All spare parts shall be individually packaged and labeled.

3. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.

4. Fuses: Provide 20 percent and no less than ten of each type and rating of fuse used in the panels specified in this section excluding those provided with individual instruments or devices.

5. Motor Starters: Provide two sets of thermal overloads for each size and type used. Provide one starter coil for each size and type used. Provide one overload relay of each size and type used.
6. General Purpose Relays: Provide 20 percent of each type used, but no less than five of each type or rating/style of relay.
7. Heavy Duty or Timing Relays: Provide 10 percent of each type used, but no less than one of each type.
8. Indicating Lamp Assembly: Provide one of each type.
9. Indicating Light Bulbs: Provide 20 percent but not less than 10 of each size, color, and type of each light bulb used in the panels specified in this section.
10. Selector Switch or Pushbutton: Provide 10 percent of each type used, but no less than one of each type.
11. DC Power Supplies: 20 percent of each size and type used, but no less than two of each size and type.
12. Panel Mounted Analog Indicator: Provide one of each type.
13. Electronic Controller: Provide one of each type.
14. Signal Conditioner or Isolator: Provide one of each type.
15. Control System Power Supply: Provide two of each type.
16. Control System I/O Cards: Provide two of each type.
17. Intrinsic Safety Barrier: Provide two of each type.
18. Surge Protective Device: 20 percent and no less than 5 of each type
19. Terminals: Provide 10 percent of each type of terminal used, but no less than five of each type.
20. Corrosion Protector: Provide 20 percent and no less than 5 of corrosion protector.
21. One hand held programming module for each electronic controller type supplied (with carrying case and instruction manuals).
22. One copy of any programming software (including job specific program listing and programming manual) associated with any programmable electronic controller or signal conditioner being supplied.
23. Provide one gallon of touch-up paint, in one-quart containers, for each type and color used for all cabinets, panels, consoles, etc., supplied under this section.
24. The spares listed above shall be packed in a manner suitable for long-term storage and shall be adequately protected against corrosion, humidity and temperature.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Control Panels or I/O Cabinets supplied under this section shall be installed per the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions" and Division 13 Contract Specification 13270 – "Surge and Lightning Protection".

B. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of control panels and I/O Cabinets shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of instrumentation and controls work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

C. Control panels and I/O Cabinets furnished under this specification shall be factory tested prior to shipment. Field installation shall consist only of setting the panel in place and making necessary electrical and pneumatic external connections.

D. The Instrumentation and Controls Subcontractor and/or Control System Subcontractor and/or Telemetry System Subcontractor shall be responsible for checking out grounding and other safe operation concerns for all supplied control panels, PLC hardware, and other sensitive electrical or electronic control system equipment prior to energization of temporary or permanent power supplies.

E. Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged units or systems shall remain on site and returned to the manufacturer after the replacement units or systems have been delivered to the site. Under no circumstances will instrumentation or controls equipment damaged by water be rehabilitated or repaired; new equipment shall be supplied, and all costs associated with replacement shall be borne by the Contractor.

F. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer. The entire damaged enclosure panel or section shall be repainted per the field painting specification Section 09900, at no additional cost to the Owner.

3.02 INSPECTION AND TESTING

A. Control Panels or I/O Cabinets supplied under this section shall be inspected and tested per the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions" and Division 13 Contract Specification 13270 – "Surge and Lightning Protection".

B. Test all instrumentation and control system components furnished under this Specification and repair or replace all defective equipment or work. Make all necessary adjustments and instruct the Owner's personnel in the proper operation of the instrumentation and controls provided.

C. All control panels and cabinets associated with the Control System and/or Telemetry System shall have a 100 % point to point wiring checkout prior to being shipped from vendor or panel fabricator. Engineer and/or Owner shall have to opportunity to witness all testing.

D. Test grounding and verify any other safe operation concerns associated with all supplied control panels, PLC hardware, intrinsic safety equipment, and other sensitive electrical or electronic control system equipment prior to energization. Supplier shall certify that the grounding and installation is in conformance with the manufacturer's warranty requirements prior to providing temporary or permanent power to any supplied equipment. Submit copies of certified installation and grounding test reports.

E. Prior to plant operation, test all instrumentation, controls, and interlocks to verify that the instrumentation and control systems will function properly and as indicated by the Contract Drawings and as noted in the approved shop drawings. Verify wiring installation against loop sheets and interconnect wiring. Verify software I/O addressing and configuration against detailed software engineering documents. Virtual I/O communication links shall be tested and verified for fully functionality per approved PLC or DCS Software Submittals.

F. All testing shall be scheduled and coordinated by the Contractor. Notify the Engineer and Owner at least two (2) weeks in advance of conducting tests. The Contractor or Subcontractors under this Division shall have qualified personnel present during all testing.

G. All test data and procedures followed during testing shall be logged, and certified copies of the logs shall be provided to the Engineer and Owner.

3.03 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

3.04 TRAINING

A. Control Panels or I/O Cabinets supplied under this section shall be incorporated in the overall training plan as required by the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions".

TABLE OF REQUIRED CONTROL PANELS

SITE/ LOCATION	PANEL TAG NO.	SERVICE	PANEL TYPE	PANEL SIZE	LOCATION / REMARKS
Remote Level Monitoring Manhole	LCP-120	Remote Level Monitoring Manhole Level Monitoring Panel	Front Access – Wall Mounted (Instrument Rack)– NEMA 4X 316 Stainless Steel	24"H x 16"W x 10"D MINIMUM	SEE ELECTRICAL DRAWINGS
Diversion Facility Electrical Building	LCP-201	Diversion Wet Well # 1 Level Monitoring Panel	Front Access – Wall Mounted – NEMA 12 Painted Steel	24"H x 16"W x 10"D MINIMUM	SEE ELECTRICAL POWER PLAN E3-103
Diversion Wet Well # 1	LCP-210	Diversion Wet Well # 1 Gas Monitoring Panel	Front Access – Wall Mounted (Instrument Rack)– NEMA 4X 316 Stainless Steel	24"H x 24"W x 10"D MINIMUM	SEE ELECTRICAL POWER PLAN E3-103
Diversion Facility Electrical Building	LCP-301	Diversion Wet Well # 2 Level Monitoring Panel	Front Access – Wall Mounted – NEMA 12 Painted Steel	24"H x 16"W x 10"D MINIMUM	SEE ELECTRICAL POWER PLAN E3-103

SITE/ LOCATION	PANEL TAG NO.	SERVICE	PANEL TYPE	PANEL SIZE	LOCATION / REMARKS
Diversion Wet Well # 2	LCP-310	Diversion Wet Well # 2 Gas Monitoring Panel	Front Access – Wall Mounted (Instrument Rack)– NEMA 4X 316 Stainless Steel	24"H x 24"W x 10"D MINIMUM	SEE ELECTRICAL POWER PLAN E3-103
Diversion Facility Electrical Building	PLC-101	Diversion Facility Local Control Panel (PLC Control System)	Front Access – Floor Mounted – NEMA 12 Painted Steel	72"H x 60"W x 18"D MINIMUM	SEE ELECTRICAL POWER PLAN E3-103
Equalization Facility Electrical Building	PLC-201	Equalization Facility Local Control Panel (PLC Control System)	Front Access – Floor Mounted – NEMA 12 Painted Steel	72"H x 60"W x 18"D MINIMUM	SEE ELECTRICAL POWER PLAN E7-103
Diversion Facility Electrical Building	LCP-3	Remote Level Monitoring RTU Communication Panel	Front Access – Wall Mounted – NEMA 12 Painted Steel	24"H x 16"W x 10"D MINIMUM	SEE ELECTRICAL POWER PLAN E3-103

SITE/ LOCATION	PANEL TAG NO.	SERVICE	PANEL TYPE	PANEL SIZE	LOCATION / REMARKS
Diversion Facility Odor Control Scrubber OC-401	OCGMP-410	Diversion Facility Odor Control Gas Monitoring Panel	Front Access – Wall Mounted (Instrument Rack)– NEMA 4X 316 Stainless Steel	24"H x 24"W x 10"D MINIMUM	SEE ELECTRICAL POWER PLAN E3-103 ??
Equalization Facility Odor Control Scrubber OC-501	OCGMP-510	Equalization Facility Odor Control Gas Monitoring Panel	Front Access – Wall Mounted (Instrument Rack)– NEMA 4X 316 Stainless Steel	24"H x 24"W x 10"D MINIMUM	SEE ELECTRICAL POWER PLAN E8-101

END OF SECTION 13200

SECTION 13250
CONTROL PANEL COMPONENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The provisions and requirements of Division 13, Section 13000 "General Provisions" of this Specification shall apply to the work specified in this section.

C. The furnishing and fabricating of control panels associated with this Specification shall be as specified in Division 13, Section 13200 "Control Panels".

1.02 SUMMARY

A. This Section covers the specification of miscellaneous components associated with Control Panels and I/O Cabinets furnished and installed under other Contract specifications.

1.03 REFERENCE STANDARDS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Reference Standards" and as specified herein.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Quality Assurance" and as specified herein.

1.05 SUBMITTALS

A. In accordance with the General Conditions and the Special Conditions of the Contract and with Contract Specifications 13000 and 13200, submit to the Engineer project specific and identified product data sheets for each component to demonstration compliance with submittal requirements of the Contract:

1.06 WARRANTY

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Warranty" and as specified herein.

PART 2 - PRODUCTS

2.01 PILOT-TYPE INDICATING LIGHTS - INCANDESCENT

A. Type: Indicating Light - Heavy duty, industrial grade, oil tight unit that utilizes a low voltage incandescent lamp with a push-to-test feature.

B. Lamp: Low voltage (6V) incandescent lamp with integral reduced voltage transformer. Lamp shall be field replaceable from front of the unit.

C. Lamp/Lens Color: Color of Lamp or Lens shall be as indicated on the instrument index.

D. Mounting: Single Hole, 30.5 mm NEMA, Octagonal-mounting ring.

E. Enclosure: Units shall be rated NEMA 13 for indoor panels. Units located outdoors, and indoor process areas, or indicated to be weatherproof shall be rated NEMA 4X.

F. Accessories: Provide legend faceplate engraved to indicate the required function of each device. Provide stackable sealed contact blocks when used for illuminated pushbutton station.

G. Acceptable Manufacturers: Allen Bradley (800H series), General Electric, Honeywell Micro-Switch, Schneider Electric (Square D Class 9001), or approved equal.

2.02 PILOT-TYPE INDICATING LIGHTS - LED

A. Type: Indicating Light - Heavy duty, industrial grade, oil tight unit that utilizes a low voltage lamp with a push-to-test feature.

B. Lamp: 6V Light Emitting Diode (LED) type (High visibility Multi-LED cluster) with integral reduced voltage transformer. Lamp shall be field replaceable from front of the unit.

C. Lamp/Lens Color: Color of LED(s) shall be as indicated on the instrument index. LEDs available only in RED, GREEN, WHITE, BLUE and AMBER (YELLOW).

D. Mounting: Single Hole, 30.5 mm NEMA, Octagonal-mounting ring.

E. Enclosure: Units shall be rated NEMA 13 for indoor panels. Units located outdoors, and indoor process areas, or indicated to be weatherproof shall be rated NEMA 4X.

F. Accessories: Provide legend faceplate engraved to indicate the required function of each device. Provide stackable sealed contact blocks when used for illuminated pushbutton station.

G. Acceptable Manufacturers: Allen Bradley (800H series), General Electric, Honeywell Micro-Switch, Schneider Electric (Square D Class 9001), or approved equal.

2.03 PUSHBUTTONS

A. Type: manually operated pushbutton station. Heavy-duty operator, industrial grade, oil tight unit with or without pilot type illumination.

B. Operator: Provide momentary flush head operator for "START" or "STOP" pushbuttons. Provide maintained mushroom head operator for "E-STOP" pushbutton.

C. Contact Blocks: Provide stackable sealed heavy-duty contact blocks. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC. Provide NO and NC Contact blocks as required per individual application.

D. Panel Mounting: Single Hole, 30.5 mm NEMA, Octagonal-mounting ring.

E. Enclosure: Units shall be rated NEMA 13 for indoor panels. Units located outdoors, and indoor process areas, or indicated to be weatherproof shall be rated NEMA 4X.

F. Accessories: Provide legend faceplate engraved to indicate the switch position / required function of each device. Provide key locked operators, padlockable covers, guards, etc, as indicated on the instrument index.

G. Acceptable Manufacturers: Allen Bradley (800H series), General Electric, Honeywell Micro-Switch, Schneider Electric (Square D Class 9001), or approved equal.

2.04 SELECTOR SWITCHES

A. Type: manually operated selector switch station. Heavy-duty operator, industrial grade, oil tight unit.

B. Operator: Provide knob or handle type manual operator. Operator for "Jog" positions shall be spring return. Number of switch positions, operator type, and number and type of contacts for each position shall be as required for each individual application.

C. Contact Blocks: Provide stackable sealed heavy-duty contact blocks. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC. Provide make-before-break bridging contacts where required. Provide NO and NC Contact blocks as required per individual application.

D. Panel Mounting: Single Hole, 30.5 mm NEMA, Octagonal-mounting ring.

E. Enclosure: Units shall be rated NEMA 13 for indoor panels. Units located outdoors, and indoor process areas, or indicated to be weatherproof shall be rated NEMA 4X.

F. Accessories: Provide legend faceplate engraved to indicate the switch position / required function of each device. Provide key locked operators, padlockable covers, guards, etc, as indicated on the instrument index.

G. Acceptable Manufacturers: Allen Bradley (800H series), General Electric, Honeywell Micro-Switch, Schneider Electric (Square D Class 9001), or approved equal.

2.05 SQUARE-TYPE SELECTOR SWITCHES/PUSHBUTTONGS WITH MULTI-LIGHT INDICATORS

A. Type: Integral multi-position selector switches or pushbutton station with illuminated, multiple lamp assembly. Assembly to be oil tight with square engraved display windows.

B. Operator: Provide knob type manual operator. Operator for "Jog" positions shall be spring return. Number of switch positions, operator type, and number and type of contacts for each position shall be as required for each individual application.

C. Contact Blocks: Provide stackable sealed heavy-duty contact blocks. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC. Provide NO and NC Contact blocks as required per individual application.

D. Lamp: Low voltage incandescent Lamp or multi-chip LED indicator with integral reduced voltage transformer. Lamp shall be field replaceable from front of the unit.

E. Lamp/Window Color: Color of Lamp(s) and/or display window(s) shall be as indicated on the instrument index.

F. Panel Mounting: Square Cutout, held to panel via assembly screw clamps from rear of panel.

G. Enclosure: Units shall be rated NEMA 13 for indoor panels.

H. Accessories: Provide display window engraved to indicate the switch position / required function of each device. Provide Color inserts in lieu of colored lamps as required.

I. Acceptable Manufacturers: Honeywell Micro-Switch CMC Series or approved equal.

2.06 POTENTIOMETERS

A. Type: Heavy duty, precision variable resistance device.

B. Specification: Three wire type Potentiometers with a total resistance of 1,000 ohms. Units shall be rated for at least 2 watts. Linearity shall be plus or minus 5 percent.

C. Mounting: circular mounting hole, inserts from rear of panel with octagonal mounting nut and lock washer.

D. Accessories: Provide a legend plate with resolution of 1 percent of entire span of potentiometer.

E. Acceptable Manufacturers: Allen Bradley, General Electric, Honeywell Micro-Switch, or approved equal.

2.07 ELAPSED RUN TIME METERS

A. Type: Six (6) digit, non-reset type electromechanical counter with quartz-crystal time base.

B. Specification: A six (6) digit, non-resetable elapsed time meter shall be connected to the 120VAC control circuit of each motor starter to indicate the total running time of each pump/motor in "hours" and "tenth of hours".

C. Mounting: Rectangular/Circular hole, Inserts in hole thru panel, held to panel front via screw clamps from rear of panel.

D. Enclosure: Units shall be rated NEMA 12 for indoor panels. Units located outdoors, and indoor process areas, or indicated to be weatherproof shall be rated NEMA 4X.

E. Accessories: provide gasket kit when mounting in NEMA 12 and NEMA 4/4X control panels.

F. Acceptable Manufacturers: ENM Company Series T50, or approved equal.

2.08 CIRCUIT BREAKERS

A. Type: Thermal Magnetic type circuit breakers to protect individual control circuits from shorts or device failures.

B. Specification: Molded case, finger safe, thermal-magnetic trip type. Provide visual indication of breaker position – ON/CLOSED and OFF/OPEN. Circuit breaker requires manual reset to the

ON/CLOSED position. All current carrying parts shall be copper. Provide type HACR circuit breakers for protection of circuits supplying heating, air-conditioning or refrigeration units. Provide type HID circuit breakers for protection of circuits supplying fluorescent, mercury vapor, metal halide, or high pressure sodium fixtures. Where ground fault interrupter or ground fault circuit interrupter circuit breakers are specified/required, they shall be of the type which provides protection for people; these shall trip on a fault of 6 milli-amperes or greater. Number of Poles, Voltage rating, and Current trip setting, and interrupting current rating per application. Circuit Breakers to be labeled in accordance with UL 489.

C. Mounting: Surface mount or Snap-on to "DIN" style mounting rail or as specified.

D. Enclosure: NEMA 1 where located inside a control panel or NEMA 3R if exposed to weather/rain.

E. Accessories: Provide auxiliary status contacts where required. Provide shunt trip where specified.

F. Acceptable Manufacturers: Allen Bradley, General Electric, Siemens, Schneider Electric (Square D), or approved equal.

2.09 HEAVY-DUTY INDUSTRIAL CONTROL RELAYS

A. Type: Heavy Duty, Machine tool type, continuous duty coil, suitable for switching inductive loads at up to 600 VAC.

B. Coil: 120VAC (or other voltage when specified) continuous duty coil. Provide Surge Suppressor across coil.

C. Contact Blocks: Provide convertible contacts (NO or NC contacts) rated for at least 10 Amps Continuous (6 Amps Break) at 600VAC (NEMA A600 Rating). Provide NO and NC Contact blocks as required per individual application.

D. Panel Mounting: Surface mounting relay base.

E. Enclosure: Vendor standard with screw type wiring terminals.

F. Accessories: Provide timing delays or latching attachments as required by the control schemes shown on the Drawings.

G. Time Delays: Pneumatic time delay relays shall be used on time delays less than 180 seconds and shall be adjustable. Solid-state time delay relays shall be used on time delays between 180 seconds and one hour.

H. Acceptable Manufacturers: Allen Bradley (700-P), General Electric (CR120 series), Siemens, Schneider Electric (Square D Class 8501 Type X), or approved equal.

2.10 GENERAL PURPOSE CONTROL RELAYS

A. Type: General Purpose, Industrial grade, suitable for switching low voltage AC or DC circuits.

B. Coil: 120VAC (or other voltage when specified) continuous duty coil with integral indicating light (LED preferred) to indicate if relay is energized. Unit shall be rated for at least 100,000 operations at rated loads.

C. Contact Blocks: Provide at least two form C contacts – DPDT relay contacts – as a minimum. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC.

D. Panel Mounting: Surface Mount Relay Base with relay hold-down spring.

E. Enclosure: Polycarbonate Dust Cover with 8 Pin (DPDT contacts) or 11 pin (3PDT contacts) plug-in socket style relay enclosure. Relay base shall have screw type wiring terminals.

F. Accessories: Provide pneumatic timing or latching attachments as required by the control schemes shown on the Drawings. Provide for push to test functionality.

G. Time Delays: Solid state time delays shall be provided with polarity protection (DC units) and transient protection.

H. Acceptable Manufacturers: Allen Bradley (700-HA), General Electric (CR420 series), IDEC, Potter & Brumfield (KAP or KUP series), Siemens, Schneider Electric (Square D Class 8501 Type K), or approved equal.

2.11 HEAVY-DUTY INDUSTRIAL TIMING RELAYS

A. Type: Heavy Duty, Machine tool type, continuous duty coil, suitable for switching inductive loads at up to 600 VAC. Relay contacts to be switched based on chosen timing function.

B. Coil: 120VAC (or other voltage when specified) continuous duty coil. Provide Surge Suppressor across coil.

C. Contact Blocks: Provide convertible contacts (NO or NC contacts) rated for at least 10 Amps Continuous (6 Amps Break) at 600VAC (NEMA A600 Rating). Provide NO and NC Contact blocks as required per individual application.

D. Panel Mounting: Surface mounting relay base.

E. Enclosure: Vendor standard with screw type wiring terminals.

F. Accessories: Provide visual indication (LED indicator preferred) that timing function is on going.

G. Time Delays: Pneumatic time delay relays shall be used on time delays less than 180 seconds and shall be adjustable. Solid-state time delay relays shall be used on time delays between 180 seconds and one hour. Time delay shall be adjustable within the specified timing range. Repeatability shall be plus/minus 1%.

H. Timing Modes

1. Provide Time Delay Function as specified in the Contract Drawings. Below is a summary of the timing functions to be supplied. To facilitate control logic changes and to minimize the Owner's inventory, provide multi-function type solid-state timing relays except when specifically specified otherwise. Provide instantaneous and/or time delay type relay contacts

as specified. If not specified, only time delay contacts shall be provided. Instantaneous contacts shall change position as soon as the timing function is initiated and time delay contacts shall change position only as dictated by the timing function.

2. ON Time Delay. Timing Contacts remain in shelf position, till control signal has remained "ON" (logic input = "true") for a specified, adjustable period of time, only after control signal has been "ON" for the full timing interval shall the timing contacts change "state". Timer resets to shelf position when control signal turns "OFF" (logic input = "false") or control power is removed.

3. OFF Time Delay. Once the control signal has been turned from "OFF" to "ON" (logic input = "true"), the timing contacts shall immediately change from shelf position and the timer shall running. The timing contacts shall not return to the shelf position until the control signal has been turned "OFF" (logic input = "false") for a specified, adjustable period of time. Resetting of control input ("ON" to "OFF" to "ON" transition) shall reset the timing period.

4. ONE-SHOT Time Delay (Latching Interval Time Delay). After the reset time (fixed delay before timer "resets" to self position) when the control signal has turned from "OFF" to "ON" (logic input = "true"), the timing contacts shall immediately change from shelf position. The timing contacts shall not return to the shelf position for a specified, adjustable period of time. Timer shall not reset till after the timing period has completed even if the control signal changes back to the "OFF" (logic input = "false").

5. Interval Timer: Once the control signal has been turned from "OFF" to "ON" (logic input = "true"), the timing contacts shall immediately change from shelf position. After the specified, adjustable time period of time, the timing contact shall return to its shelf position and the timer will automatically reset. Timer shall reset if control signal changes back to "OFF" (logic input = "false") or if the timing period expires.

6. Repeat Cycle Timer (ON and OFF Time Delay): Timing Relay switches from shelf to energized positions. ON and OFF time delays shall be individually adjusted or change be set independently depending on the relay – Provide the type specified on the Contract Drawings – Provide separate ON and OFF time delays as a default. During the OFF time delay, the timing contact remains in the shelf position. After the OFF time delay, the timing contact changes position and remains "energized" during the ON time delay period. The cycle will repeat till the control signal as long as the control signal (or power supply) remains "ON" (logic = "true"). The timing contact will return to shelf position when the control signal is switched "OFF".

I. Acceptable Manufacturers: Allen Bradley (700-PT or PS), General Electric (CR122 series), Siemens, Schneider Electric (Square D Type F or RE4), Tyco Electronics (Agastat 7000 Series, or approved equal.

2.12 GENERAL PURPOSE TIMING RELAYS

A. Type: General Purpose, Industrial grade, suitable for switching low voltage AC or DC circuits. Relay contacts to be switched based on chosen timing function.

B. Coil: 120VAC (or other voltage when specified) continuous duty coil with integral indicating light (LED preferred) to indicate if relay is energized. Unit shall be rated for at least 100,000 operations at rated loads.

C. Contact Blocks: Provide at least two form C contacts – DPDT relay contacts – as a minimum. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC.

D. Panel Mounting: Surface Mount Relay Base with relay hold-down spring.

E. Enclosure: Polycarbonate Dust Cover with 8 Pin (DPDT contacts) or 11 Pin (3PDT contacts) plug-in socket style relay enclosure. Relay to have pin or blade plug-in connections to the relay socket base. Relay base shall have screw type wiring terminals. Multi-function Solid State Timers are surface mounted with integral screw type wiring terminals.

F. Accessories: Provide visual indication (LED indicator preferred) that timing function is on going.

G. Time Delays: Provide Electromechanical or Solid State timing relays as specified on the Contract Drawings. If not specified, provide traditional electromechanical tubular relays with pin connections to relay socket. Time delay shall be adjustable and available in ranges from .1 second to 4.5 hours. Repeatability shall be plus/minus 1%. Reset time shall be less than 0.5 second.

H. Timing Modes

1. Provide Time Delay Function as specified in the Contract Drawings. Below is a summary of the timing functions to be supplied. To facilitate control logic changes and to minimize the Owner's inventory, provide multi-function type solid-state timing relays except when specifically specified otherwise. Provide instantaneous and/or time delay type relay contacts as specified. If not specified, only time delay contacts shall be provided. Instantaneous contacts shall change position as soon as the timing function is initiated and time delay contacts shall change position only as dictated by the timing function.

2. ON Time Delay. Timing Contacts remain in shelf position, till control signal has remained "ON" (logic input = "true") for a specified, adjustable period of time, only after control signal has been "ON" for the full timing interval shall the timing contacts change "state". Timer resets to shelf position when control signal turns "OFF" (logic input = "false") or control power is removed.

3. OFF Time Delay. Once the control signal has been turned from "OFF" to "ON" (logic input = "true"), the timing contacts shall immediately change from shelf position and the timer shall running. The timing contacts shall not return to the shelf position until the control signal has been turned "OFF" (logic input = "false") for a specified, adjustable period of time. Resetting of control input ("ON" to "OFF" to "ON" transition) shall reset the timing period.

4. ONE-SHOT Time Delay (Latching INTERVAL Time Delay). After the reset time (fixed delay before timer "resets" to self position) when the control signal has turned from "OFF" to "ON" (logic input = "true"), the timing contacts shall immediately change from shelf position. The timing contacts shall not return to the shelf position for a specified, adjustable period of time. Timer shall not reset till after the timing period has completed even if the control signal changes back to the "OFF" (logic input = "false").

5. Interval Timer: Once the control signal has been turned from "OFF" to "ON" (logic input = "true"), the timing contacts shall immediately change from shelf position. After the specified, adjustable time period of time, the timing contact shall return to its shelf position

and the timer will automatically reset. Timer shall reset if control signal changes back to "OFF" (logic input = "false") or if the timing period expires.

6. Repeat Cycle Timer (ON and OFF Time Delay): Timing Relay switches from shelf to energized positions. ON and OFF time delay settings shall be adjustable – both delays may be set for the same time delay value, total cycle time is adjustable as well as percentage ON Time, or both time delays can be set independently depending on the relay – Provide the type specified on the Contract Drawings – Provide separate ON and OFF time delays as a default. During the OFF time delay, the timing contact remains in the shelf position. After the OFF time delay, the timing contact changes position and remains "energized" during the ON time delay period. The cycle will repeat till the control signal as long as the control signal (or power supply) remains "ON" (logic = "true"). The timing contact will return to shelf position when the control signal is switched "OFF".

I. Acceptable Manufacturers: Allen Bradley (700-FS or HS), Cutler Hammer (TR Series), Danaher/Eagle Signal, General Electric, Potter & Brumfield (KAP or KUP series), Siemens, Schneider Electric (Square D Type JCK), Tyco Electronics (Agastat SSC Series), or approved equal.

2.13 INTRINSIC SAFETY RELAYS

A. Type: Specialty solid state protective relay to insure that the energy level associated with an electric circuit connecting thru an electrically "hazardous" area is always below the explosive limit of any potentially flammable gases or liquids that might be present in the area.

B. Design Criteria: Intrinsic Safety Relays shall be located in non-hazardous areas and shall be designed to provide personnel and equipment protection in accordance with National Electrical Code. See Contract Specification 13000 Section 2.03. Intrinsic Safety Relays shall be designed specifically for each individual circuit to be protected and shall be compatible with the circuit voltage and entity parameters of instrumentation and associated devices that are part of that circuit. Circuit Design Calculations to be submitted with each Intrinsic Safety Relay to be utilized.

C. Certification: Each Intrinsic Safety Relay to be certified by FM and UL as suitable for providing an auxiliary means of protection for the associated apparatus located in the specified electrically hazardous area classification associated with the electric circuit to be protected. Provide a copy of the Certification Information with each submittal.

D. Panel Mounting: Surface Mount or "DIN" style mounting rail.

E. Enclosure: Manufacturer Standard. Provide screw type wiring terminals.

F. Acceptable Manufacturers: Gems Sensor, MTL, Pepperl Fuchs, R Stahl, Turck, or approved equal.

2.14 ALTERNATING RELAYS

A. Type: General Purpose, Industrial grade, cycle timing relay, suitable for switching starting control circuit associated with two or more pumps in a common service. Running time associated with each pump shall be limited by the timer value to even the run-time for each motor/pump.

B. Coil: 120VAC (or other voltage when specified) continuous duty coil with integral indicating light (LED preferred) to indicate if relay is energized. Unit shall be rated for at least 100,000 operations at rated loads.

C. Contact Blocks: Provide two form C contacts – DPDT relay contacts – as a minimum (Duplex Pump Controls) or three form C contactors for Triplex Pumps, Quaternary Pump Alternators require four form C contacts. Contacts for 120VAC control circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for at least 5 Amps at

D. Panel Mounting: Surface Mount Relay Base with relay hold-down spring.

E. Enclosure: Polycarbonate Dust Cover with 8 Pin (DPDT contacts) or 11 pin (3PDT contacts) plug-in socket style relay enclosure. Relay base shall have screw type wiring terminals.

F. Time Delays: Solid state time delays shall be provided with polarity protection (DC units) and transient protection. Timer shall run continuous as long as the Pump Mode selector is left in the auto sequencing position.

G. Acceptable Manufacturers: ATC Diversified Electronics, Sta-Con, Time Mark, or approved equal.

2.15 PHASE MONITOR

A. Type: General Purpose, Industrial grade, protective relay to protect all motor starter circuits from damage from single phasing or other incoming power faults. Provide a Phase monitoring relay on each 480VAC power feed.

B. Protective Circuit: Three phase or single phase monitoring as appropriate. Three phase unites shall detect phase unbalance (adjustable setting), phase reversal, or low/high voltage. Phase monitoring relay shall be wired to the motor starter common trouble circuit to trip all associated motor starters when fault occurs.

C. Contact Blocks: Provide at least two form C contacts – DPDT relay contacts – as a minimum. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC.

D. Panel Mounting: Surface Mount Relay Base with relay hold-down spring.

E. Enclosure: Polycarbonate Dust Cover with 8 Pin (DPDT contacts) or 11 pin (3PDT contacts) plug-in socket style relay enclosure. Relay base shall have screw type wiring terminals.

F. Acceptable Manufacturers: ATC Diversified, General Electric, Schneider Electric (Square D Class 8430 Type MPS or RM3), Sta-Con, Time Mark, or approved equal.

2.16 FUSES – AC CONTROL POWER

A. Type: Non-renewable cartridge fuses; for short-circuit protection of AC power feeds to control panel components and wiring.

B. Fuse Type: Compatible with NEMA Standard FU 1, non-renewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit.

C. Fuse Applications:

1. For Incoming AC Power Feed service or Motor Branch circuit requirements see Division 16 Specification 16475 "Fuses".

2. Control Power Circuits (Motor starter controls): Class CC time-delay Bussmann CC-Tron FNQ-R or equivalent unless otherwise specified by the controls manufacturer or in the drawings.

3. General Purpose Instrumentation/Electronic Circuits: Fast Acting Bussmann AGC (¼" x 1-1/4" Glass Fuses) or Slow Blow Busmann MDL (1/4" x 1-1/4" Glass Fuses) where required or equivalent.

D. Installation: Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

E. Accessories: Provide one fuse puller for each of the fuse sizes as necessary and recommended by the manufacturer.

F. Acceptable Manufacturers: Cooper Industries Inc., Bussman Div; General Electric Co, Wiring Devices Div; Gould Shawmut; Tracor Inc., Littelfuse, Inc. Subsidiary, or approved equal.

2.17 MISCELLANEOUS INSTRUMENTS AND CONTROLS

A. When required, miscellaneous panel mounted analog instrumentation, panel meters, controllers, timing relays, signal conditioners, and voltage/current switches shall be supplied as specified in Division 13 Specification 13300 "Instrumentation Specifications" or as specified elsewhere in the Contract Specifications.

2.18 RECEPTACLES

A. Provide duplex GFI (Ground Fault Interrupting) type convenience receptacle per Division 16 Specification 16141 "Wiring Devices" Paragraph 2.02. The convenience outlet shall be individually protected by a circuit breaker.

2.19 LIGHT SWITCH/DATA JACKS

A. Any internal AC power "wall switch" – i.e. for fluorescent light fixture - or Data Jack (telephone, Ethernet 10Base 2, Ethernet 10Base T, etc.) – wall type plug-in type receptacle - receptacle is to be supplied per Division 16 Specification 16141 "Wiring Devices".

2.20 MOTOR STARTERS

A. Any Manual or Magnetic Motor Starters included in Control Panels shall be supplied as specified in Division 16 Specification 16481 Section 2.04 (magnetic motor starters to be NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated). Provide individual flange mounted lockable disconnect to be located on the front of the associated control panel. Disconnect shall have (1) Provision to padlock unit disconnect handle in the OFF position, and (2) Mechanical interlock to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open. Additionally, for each motor starter, provide the following components on the front of the control panel as a minimum: (1) Run and Fault indicating lights, (2) fault reset pushbutton, and (3) non-resetable elapsed run time

meter. Provide laminated starter-wiring diagram and overload heater selection table adhered inside each control panel door.

2.21 CONTROL POWER TRANSFORMERS

A. Provide in accordance with Division 16 Specifications. Minimum Requirements: Two-winding type, 120 Volts AC secondary, fused in accordance with the NEC requirements. Control power transformers power transformers shall have two primary fuses and one secondary fuse. Control power transformers shall be sized to accommodate all loads within the control panel and shall have a minimum of 100 VA extra capacity for external relays, lights, etc.

2.22 LIGHTNING/SURGE SUPPRESSOR

A. All AC power feeds to control panels shall be protecting against lightning and power surge shall be required by the Contract Specifications including Division 13 Contract Specification 13270 "Surge and Lightning Protection". Additionally, Motor Starters furnished in Control Panels and/or other Cabinets furnished under this Specification shall additionally comply with the AC power surge protection requirements as specified in Division 16 Contract Specification 16445 "Surge Protective Devices for Low-Voltage Electrical Power Circuits."

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Components supplied under this section shall be installed and tested per the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions" and Division 13 Contract Specification 13200 – "Control Panels".

B. Motor Starters located in Control Panels shall be tested per Division 16 Specifications including 16010 "Basic Electrical Requirements" and 16481 "Low Voltage Motor Control Centers".

END OF SECTION 13250

SECTION 13270
SURGE AND LIGHTNING PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The provisions and requirements of Division 13, Section 13000 "General Provisions" of this Specification shall apply to the work specified in this section.

C. The provisions and requirements of Division 16 Contract Specification 16445 "Surge Protective Devices for Low-Voltage Electrical Power Circuit" shall apply to the work specified in this section.

1.02 SUMMARY

A. This Section covers the provision for transient surge and lightning protective devices (surge protective devices) for all instrumentation and controls associated with this project.

B. Provide a surge protective device for each device that receives AC power and for each device that sends discrete or analog signals to/from the Control System and/or Telemetry System and for digital communication signals that interface to the Control System and/or Telemetry Systems.

C. Furnish all labor, supervision, materials, equipment and incidentals required to install, complete and ready for operation, the transient surge and lightning protection system described in this section and in accordance the Division 13, Section 13000 "General Provisions" of these Contract Specifications.

1.03 REFERENCE STANDARDS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Reference Standards" and as specified herein.

B. The transient surge and lightning protection design, equipment, materials, and installation shall be provided in accordance with the Instrumentation Society of America (ISA) Standards and Recommended Practices, with the National Electrical Code (NEC), and with the latest edition of all codes and standards of the following organizations:

1. Federal Communications Commission (FCC), including (but not limited to):
   a. FCC Regulations Part 15 concerning radio frequency transmission and interference
2. Institute of Electrical and Electronics Engineers (IEEE), including (but not limited to):
   a. IEEE Standard C62.22- Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.
   b. IEEE Standard C62.36 - Test Methods for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits.
   c. IEEE Recommended Practice C62.41- Characteristics of Surges in Low Voltage AC Power Circuits.

d. IEEE Recommended Practice C62.45- Guide on Surge Testing for Equipment connected to Low Voltage AC Power Circuits.

e. IEEE Standard C62.64 - Specifications for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits.

3. National Electrical Manufacturers Association (NEMA)
   a. ICS 1 - Industrial Control and Systems: General Requirements.
   b. ICS 2 - Industrial Control and Systems: Controllers, Contactors and Overload Relays, Rated Not More than 2000 Volts AC or 750 Volts DC.
   c. ICS 3 - Industrial Control and Systems: Factory Built Assemblies
   d. ICS 4 - Industrial Control and Systems: Terminal Blocks.
   e. ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. ICS 6 - Industrial Control and Systems: Enclosures.
   g. ICS 19 - Industrial Control and Systems: Diagrams, Device Designations, and Symbols.
   h. LS-1 - Low Voltage Surge Protection Devices.
   i. NEMA Standard 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

4. Underwriter's Laboratories (UL), including (but not limited to):
   a. UL 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
   b. UL 497 – Standard for Protectors for Paired Conductor Communications Circuits.
   c. UL 508 – Industrial Control Equipment.
   d. UL 698 – Industrial Control Equipment for use in hazardous areas.
   e. UL 1283 - Standard for Electromagnetic Interference Filters.
   f. UL 1363 – Standard for Relocatable Power Taps.
   g. UL 1449 – Standard for Transient Voltage Surge Suppressors.
   h. UL 1604 -Standard for Electrical Equipment for Use in Class I and II, Division 2, and Class III Hazardous (Classified) Locations.

5. All applicable state and local codes, amendments, regulations and practices.

6. Appropriate Authorities Having Jurisdiction.

C. Where codes and/or standards conflict, the most conservative document shall be followed.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

A. The supplier of instrumentation and controls associated with this Division shall provide surge protective devices from a manufacturer that has been regularly engaged in the development, design, testing, and manufacturing of said devices for a period of five (5) years or more and whose products have been in satisfactory use in similar service. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

B. Actual installation of the equipment and materials specified by this Division need not be performed by employees of the supplier; however, the supplier shall be responsible for the on-site technical supervision of the installation.

C. The supplier shall furnish equipment and materials, which shall be the product of one manufacturer to the maximum practical extent. Where this is not practical, all equipment of a given type shall be the product of one manufacturer.

1.05 SUBMITTALS

A. In accordance with the General Conditions and the Special Conditions of the Contract and with Contract Specification 13000, submit to the Engineering the following documentation to demonstration compliance with submittal requirements of the Contract:

B. Shop drawings including copies of all drawings, parts lists, product data, and other materials shall be submitted and shall include:

1. Installation Drawings and Details of surge protective devices to be installed in the field.
2. Complete Bill of Materials of all surge protective devices to be installed in the field. Bill of Materials shall reference installation drawings or details and shall include reference #, manufacturer, model number, description, and quantity for each item.
3. Project specific identified product data sheets for each component in the Bill(s) of Materials.
4. Instruction Manuals for each device containing device specifications and manufacturer installation and maintenance requirements.
5. Surge Protection Device certifications and test reports.
6. Complete list of Spare Parts, Expendables, and Test Equipment to be provided.

C. After Fabrication, Installation, and Testing are complete and approved, submit Record Documents per Contract Specification 13000 Section "Record Drawings".

D. After Record Drawings have been approved, submit Operation and Maintenance Manuals per Contract Specification 13000 Section "Operation and Maintenance Manuals".

1.06 WARRANTY

A. Provide a five (5) year replacement warranty for all materials supplied.

B. The surge protective device (SPD) and supporting components shall be guaranteed by the manufacturer to be free of defects in material and workmanship for a period of at least five (5) years from the date of substantial completion of service and activation of the system to which the suppressor is attached.

C. A Surge Protective Device (SPD) that shows evidence of failure or incorrect operation during the warranty period shall be replaced free of charge. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this specification shall not apply to this section. That is, the warranty is to cover the effects of lightning, single phasing, and all other electrical anomalies. The warranty shall cover the entire device, not just various components,

such as modules only. Replacement of the surge protective device shall not be limited by the number of occurrences of failures during the warranty period.

D. The installation of surge protective devices (SPDs) in or on electrical distribution equipment and/or inline with or integral to instrumentation and controls shall in no way compromise or violate equipment listing, labeling, or warranty of the associated power distribution equipment and/or associated instrumentation and controls.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Transient Surge and Lightning protection shall be provided to protect all instrumentation and controls from induced voltages and power surges propagating along the discrete or analog signal and/or power supply lines or digital communication connection to the Control system and/or Telemetry system. The protection systems shall be such that the surge protective device shall not interfere with normal operation, but shall lower the induced voltage level or transient surge level to be less than the instrument's (or control device's) surge withstanding level, and shall be maintenance free and self-restoring.

B. The surge protection device (SPD) furnished under this Specification shall provide transient voltage surge suppression (TVSS) for the Instrumentation and Controls associated with or provided under this Division. The surge protective system device shall provide complete protection of all AC (power supply and discrete control signals) and DC (Control/Telemetry System discrete or analog signals or digital data communication signals) electrical circuits and associated electronic equipment from the effects of lightning induced voltages, external switching transients and internally generated switching transients.

C. All surge protection devices shall be suitable for the environmental conditions and electrical area classifications of the individual installation locations. Surge protective devices not inherently suitable for the environmental conditions and/or electrical area classification shall be mounted inside suitable enclosures to guarantee safe and long-term operation of said devices.

D. The supplier of instrumentation and controls associated with this Division shall provide with each instrument and control device the appropriate surge protective device as required by this Division. Instrumentation and Controls Subcontractor shall provide any additional surge protective devices, materials, supervision, installation, and testing if the supplier of any instrumentation and controls under the Contract Specifications does not satisfy the intent of this specification.

2.02 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with contract requirements, manufacturers offering Products that may be incorporated in the Work include, but are not limited to, the following:

1. AC Power Protection Devices (must comply with UL 1449):
   a. Emerson Electric/EDCO
   b. Advanced Protection Technologies.
   c. Eaton/Cutler-Hammer.
   d. Joslyn.

e. Innovative Technologies, Inc.
f. MCG Surge Protection.
g. MTL Surge Technologists (Telematic).
h. Northern Technologies or equal.

2. Discrete or Analog Signal Protection Devices (must comply with UL 497):
   a. Emerson Electric/EDCO
   b. Joslyn.
   c. MTL Surge Technologists (Telematic).
   d. Pepperl & Fuchs.
   e. Phoenix Contact or equal.

3. Digital (Data) Communication Line Protection Devices (must comply with UL 497):
   a. Emerson Electric/EDCO
   b. Joslyn.
   c. MCG Surge Protection.
   d. MTL Surge Technologists (Telematic).
   e. Northern Technologies.
   f. Pepperl & Fuchs.
   g. Phoenix Contact or equal.

B. City of Atlanta (COA) Preferred Applications: The following is a list of applications and default pre-approved transient surge protectors to be provided for the project (exceptions to these requirements shall be clearly noted and require prior approval before procurement and/or installation).

1. Field mounted transient surge protectors for analog signal circuits shall be EDCO SLAC Series suppressor for 4-wire analog signal transmitters mounted in the field.
2. Field mounted transient surge protectors for analog signal circuits shall be EDCO Series SS64/SS65 for field mounted 2-wire analog signal transmitters.
3. Panel mounted transient surge protectors for analog signal circuits shall be EDCO Series DRS din rail panel mounted.
4. Panel mounted transient surge protectors for AC power circuits shall be EDCO Model HSP121BT-1RU.

2.03 DESIGN

A. Remotely Mounted Protective Devices - Lightning and Transient Surge protection associated with in-line and field mounted instrumentation and controls shall be mounted within the instrument enclosure or within a separate external junction box closely-coupled to the instrument enclosure. Protective devices shall be as located as closely as possible to the instrument or control device being protected. External protective devices shall be housed in a suitable enclosure with proper grounding to ensure proper operation and personnel protection. External Enclosures for non-hazardous outdoors and wet locations shall be NEMA 4X rated. External enclosures for non-hazardous dry indoors locations shall be NEMA 12 rated. External enclosures for hazardous locations shall be NEMA 7 (Class 1 Indoors dry location), NEMA 8 (Class I Wet or Outdoors location), or NEMA 9 (Class II Indoors location) rated.

B. Protection of the AC Power Supply

1. Transient Surge / Lightning protection shall be provided for the AC power supplies to all instrument and controls. The surge protective device should meet IEEE C-62-41 Standards.

2. A dedicated isolation transformer shall protect the AC power feed to the Control System or Telemetry System equipment with individual surge protective devices associated with each individual piece of equipment or component. The isolation transformer shall be as provided by the Electrical Contractor as part of his scope of supply. AC isolation transformers shall have their neutral phase grounded per the National Electric Code to prevent damage to the instrumentation and controls from floating AC supply voltages.

3. The AC power feed to each inline or field mounted instrument or control panel, regardless of location (indoor or outdoor), shall be protected by series connected surge protective devices. Surge Protective Devices shall have external screw terminals for each phase, neutral, and ground and shall accept conductors size AWG #10 thru AWG #14.

4. Each surge protective device shall be a hybrid solid-state design that complies with UL Standard 1449 and that is maintenance free and auto-resetting. Each surge protective device may utilize metal oxide varistors (MOV's) or silicon avalanche diodes (SAD's). Each surge protective device should consist of more than one protective stage such failure of any protective stage shall not compromise the surge protection offered by the device. All internal components shall be hardwired utilizing low impedance connections.

5. The surge protective device shall include a high performance EMI/RFI noise rejection filter. The noise attenuation shall be no less than 45 dB at 100 KHz.

6. The surge protective device may contain have internal fusing for each suppression element. Failure of a single component shall not short-circuit or crowbar the power to connected loads.

7. Each surge protective device shall be designed to provide all modes of transient surge protections (i.e. for single phase AC, the surge protective device shall protect against surges from Line (L) to Neutral (N), from Line (L) to Ground (G), and from Neutral (N) to Ground (G)). The transient response of each device shall be less than 5 nanoseconds.

8. All surge protective devices shall be tested and certified to be in compliance with the IEEE 8x20 microsecond current wave surge suppression test per IEEE Standard C62.45. Surge protective device shall be rated for at least 18 kiloAmpere surge withstanding rating using the IEEE 8x20 microsecond current wave surge suppression test per IEEE Standard C62.45

9. The maximum let through voltage shall not exceed:
   a. 120/208 Volts Supply: 170/500 ANSI/IEEE Category B3/C3
   b. 277/480 Volts Supply: 300/900 ANSI/IEEE Category B3/C3

10. Maximum continuous operating voltage shall be greater than 115 percent of the nominal operating voltage.

11. The surge protective device shall monitor the online status of each stage of the surge protection system and power loss in any of the phases. Failure detection system shall monitor more than the status of each of the protective fuses, if provided. Long life individual component failure-indicators shall be provided on the front of the enclosure. Also provide remote failure alarm contacts – contacts shall be dry Form C type rated for 10 Amps at 120VAC.

C. Protection of Discrete and Analog Signal Lines

1. All discrete and analog signal lines wired to the control system (PLC, PC or DCS based I/O Cards) and any other new or reworked control panel shall be protected through the use of surge protective devices.
2. These surge protectors shall be provided at source and destination ends of these signal lines and as close to the instruments and controls as possible.
3. Each surge protective device shall be a hybrid solid-state design that complies with UL Standard 497 and that is maintenance free and instantly auto-resetting. Each surge protective design may include metal oxide varistors (MOVs) or silicon avalanche diodes (SADs), line to line and line to ground inductors, and Zener diodes or gas tube arrestors as appropriate. MOVs may only be utilized where the any MOV leakage current will not impair the receiving device's ability to accurately measure (within 0.1%) the signal being transmitted (especially when high input impedance I/O circuits are involved).
4. Surge protective device located in control panels shall be capable of being "DIN" railed mounted.
5. When plastic materials are used in the enclosures for surge protective devices, all plastics shall be tested for flammability per the UL flammability testing standard UL 94.
6. Each surge protective device shall be designed to provide all modes of transient surge protections (i.e. the surge protective device shall protect against surges from Line (L) to Line (L) and from each Line (L) to Ground (G)). The transient response of each device shall be less than 5 nanoseconds.
7. Surge protective devices with replaceable fuse and local disconnect shall be provided where called out on the Contract Drawings.
8. Field mounted Surge protective devices for 4 wire (analog) transmitters may utilize a single composite surge protective device that protects both the AC Power Source as well as the analog signal line.
9. All surge protective devices shall be tested and certified to be in compliance with the IEEE 8x20 microsecond current wave surge suppression test per IEEE Standard C62.45. Surge protective device shall be rated for at least 10 kiloAmpere surge withstanding rating using the IEEE 8x20 microsecond current wave surge suppression test per IEEE Standard C62.45.
10. Surge protective devices located in electrically hazardous areas shall be designed to be operated in the appropriate hazardous environment. Additional, such surge protective devices shall be certified as being acceptable to operate in the hazardous area per UL 1604 and shall be installed in full compliance with the National Electrical Code (NFPA 70).

D. Protection of Digital Communication Lines

1. All digital communication lines (telephone, RS-232, RS-485, Ethernet/LAN, coaxial RF – only applies to non-fiber optic connections) connected to the Control System and/or Telemetry system shall be protected through the use of transient surge and lightning protection devices.
2. These surge protectors shall be provided at source and destination ends of these digital communication lines and as close to protected device as possible.
3. Each surge protective device shall be a hybrid solid-state design that complies with UL Standard 497 and that is maintenance free and instantly auto-resetting. Each surge

protective design may silicon avalanche diodes (SADs), line to line and line to ground inductors, and Zener diodes or gas tube arrestors as appropriate. The surge protective device design shall not attenuate or misshape or limit the inherit frequency of any digital (data) communication signal being protected.

4. Each surge protective device shall be designed to provide all modes of transient surge protections (i.e. the surge protective device shall protect against surges from Line (L) to Line (L) (or Positive to Negative) and from each Line (L) to Ground (G)). The transient response of each device shall be less than 1 nanosecond.

2.04 MAINTENANCE REQUIREMENTS

A. Maintenance Requirements of all supplied control panels and cabinets shall be in full conformance with the Contract Specifications and with Division 13 Contract Specification 13000 Section "Maintenance Requirements" and as specified herein.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine equipment for compliance with contract documents and other conditions affecting performance of the transient voltage surge suppression and lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install surge protective devices and connect or wire each surge protection device to the signal or power line being protected in according to manufacturer's written instructions.

B. Install surge protective device as close as physically possible to instrument or control device being protected for maximum protection and optimum performance. Remember that transient surge and lightning protection is required for both the signal-generating device (transmitter, etc.) and for the signal-receiving device (control panel or control system I/O card).

C. Grounding - Lightning and Transient Surge protection systems shall be properly grounded with ground wires for all surge protectors connected to a good earth ground. Where practical each ground wire shall be run individually and insulated from each other. All surge protective device grounds in common control panel or I/O cabinet shall be connected to the same grounding point. Grounding in such control panels or I/O Cabinets shall be individually run to dedicated isolated copper bus bar(s) before connection at a single point to a good earth ground.

D. If more than one surge protective device is connected in series, ensure that the final installation will not diminish the protection required (i.e. failure of one surge protective device will compromise the protection of the non-failed surge protective device(s), etc).

3.03 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

3.04 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.05 CLEANING

A. Upon completion of installation of system, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 13270

SECTION 13300
INSTRUMENTATION SPECIFICATONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The provisions and requirements of Division 13, Section 13000 "General Provisions" of this Specification shall apply to the work specified in this section.

1.02 SUMMARY

A. This Section includes field instrumentation, analyzers and other controls components not specified in other sections of this Division.

B. Provide those instrumentation and controls as listed in the Drawings, P&IDs and Instrument Index that are not furnished by others.

C. Furnish all labor, supervision, materials, equipment and incidentals required to install, complete and ready for operation, the instrumentation and controls as described in this section and in accordance the Division 13, Section 13000 "General Provisions" of these Contract Specifications.

1.03 REFERENCE STANDARDS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Reference Standards" and as specified herein.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Quality Assurance" and as specified herein.

1.05 SUBMITTALS

A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. In accordance with the General Conditions and the Special Conditions of the Contract and with Contract Specification 13000, submit to the Engineer project specific and identified product data sheets for each component to demonstration compliance with submittal requirements of the Contract.

C. For all instruments and control devices, provide a complete Instrument Spec Sheet; vendor product information including Model Number breakdown; Product Data Cut sheets; Instruction Manuals; and sizing calculations where applicable.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Delivery, Storage, and Handling" and as specified herein.

1.07 PROJECT/SITE REQUIREMENTS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Project/Site Requirements" and as specified herein.

1.08 WARRANTY

A. Supplier shall warrant all equipment provided under this Section to be free of defects in materials or workmanship for a period of at least one year starting on the date of substantial completion as defined in Section 7.3 of Archer-Western's Contract with Fulton County. In general, the substantial completion date will occur prior to commencement of the acceptance tests and 120-day Whole Plant Testing. Warranty periods will not start based on date of delivery of the equipment.

PART 2 - PRODUCTS

2.01 FIELD INSTRUMENTATION

A. Flow Transmitter – Magmeter

1. Type: Flow measurement utilizing the Farad principle for creation of an induced voltage when a moving conductor (process fluid) passes through a magnetic field. Induced voltage is proportional to the average velocity of the fluid.
2. Design Criteria: Provide low frequency Pulsed DC type electromagnetic induction type flow meter. Flow tube to be wafer style or flanged as specified. Flow meter to be factory pressure tested and flow calibrated (provide test report listing at least 3 test points). Transmitter shall be microprocessor based and shall provide linear output. Transmitter shall be field configurable (provide password protection). Transmitter shall have local display of level in Engineering Units. Transmitter shall be resistant to EMI/RFI interference. Transmitter can be integral to flow tube or remotely mounted (2" pipe mounting bracket) as specified. Provide grounding rings when utilized with lined or plastic pipe. Install grounding straps between flanges and flow meter body. Ground the flow meter body (and grounding rings if provided) as required by the manufacturer.
3. Materials of Construction: Flow tube to be epoxy painted carbon steel unless Stainless Steel is specified. Flow tube to be lined with a material recommend by the manufacturer for the intended service. The flow tube is typically lined with polyurethane for municipal water and

sewage service although other liners like neoprene rubber, Teflon, and ceramic may be required based on process conditions. Electrodes to be 316 Stainless Steel or other material selected for compatibility with process conditions and fluid. Transmitter enclosure to be NEMA 4X rated or as specified. Flow meter and transmitter to be suitable for operation in the associated area classification.

4. Process Connections: Wafer Body or Flanged per pipe spec. General Contractor or Mechanical Contractor to provide flange gaskets to prevent leakage.

5. Transmitter Output: 4 – 20 ma Current Loop (analog output) and/or pulsed DC when specified – provide HART Protocol or Foundation Fieldbus digital outputs when specified.

6. Accuracy: approximately +/- 0.25 % of reading for velocities above 3 feet per second. Flow Turndown: at least 10:1. Repeatability shall be greater than 0.25% of full scale.

7. Accessories: Remote transmitter mounting bracket and interconnect cabling (provide common spool of cable for all magmeter provided – include at least 30 feet of cable per flow meter – verify length with electrical contractor) when remote transmitter is specified. Transmitter shall provide pulsed DC output or remote input for driving output to 4 ma (zero) when specified. Where required, provide a continuous ultrasonic electrode cleaning system.

8. Mounting: Flow tube to be mounted between two pipe flanges. Provide liner protectors (grounding rings) when elastomers are used for liner material. General Contractor or Mechanical Contractor to provide flange gaskets to prevent leakage.

9. Acceptable Manufacturers: ABB Instrumentation, Endress and Hauser, Foxboro, Krohne, or equal.

10. Instrument Schedule:

Instrument Tag Number	Design Flow	Flow Units	Line Size	Process Connection	Area Classification	Notes
FE/FIT-210	0-45	MGD	36 inches	Flanged ?	Class 1 Div 2	Diversion Wet Well # 1 Discharge Flow
FE/FIT-310	0-45	MGD	36 inches	Flanged ?	Class 1 Div 2	Diversion Wet Well # 1 Discharge Flow
FE/FIT-503	0-40	MGD	48 inches	Flanged ?	Class 1 Div 2	Equalization Tank Discharge Flow
FE/FIT-510	0-2000	GPM	8 inches	Flanged ?	Class 1 Division 2	Equalization Tank Flushing Water Flow
FE/FIT-531	0- 7,000	GPM	16 inches	Flanged	Class 1 Div 2	Equalized Flow Return Pump # 1 Flow
FE/FIT-532	0- 7,000	GPM	16 inches	Flanged	Class 1 Div 2	Equalized Flow Return Pump # 2 Flow
FE/FIT-533	0- 7,000	GPM	16 inches	Flanged	Class 1 Div 2	Equalized Flow Return Pump # 3 Flow

11. Notes:
    a. Submit magmeter sizing calculations with instrument data sheet, instruction manual, installation guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. Consult with vendor to determine upstream and downstream straight run requirements depending on pipe arrangement.

B. Flow Transmitter –Open Channel – Flume

1. Type: Special ultrasonic level transmitter that has the ability to determine the flow rate thru a flume or weir by utilizing preprogrammed flow equations for the type and size of weir/flume whose liquid level is being measured.

2. Design Criteria: Flow transmitter shall be complete with ultrasonic transducer, transducer mounting hardware, ambient air temperature compensation, freeze protection (if required), transmitter, or other accessories required for continuous operation during all environmental conditions. Flow transmitter shall be a microprocessor-based design that is designed for open channel flow measurements and is pre-programmed to convert liquid level to volumetric flow rate for any associated standard weir or flume. Transmitter shall be able to compensate for false or intermittent echoes while providing transducer failure or loss of signal alarming. Transmitter shall have local display of level in Engineering Units. Transmitter shall be resistant to EMI/RFI interference.

3. Materials of Construction: Transducer body to be made from thermoplastic or similar material suitable for operating conditions. Mounting hardware to be 316 Stainless Steel or other material suitable for the operating environment. Display/Transmitter enclosure to be NEMA 4X rated or as specified. Complete flow transmitter installation including transducer, temperature elements (if provided), heaters (if provided), and transmitter shall be suitable for operation in the associated area classification.

4. Process Connections: Supplier shall mount transducer above flume's stilling well at a suitable height beyond the transmitter blanking distance. Complete details of the intended transducer installation and interconnect wiring shall be submitted for approval prior to actual installation.

5. Transmitter Output: 4 – 20 ma Current Loop (analog output) and/or discrete contact closures as specified – provide HART Protocol or Foundation Fieldbus digital outputs when specified.

6. Accuracy: approximately +/- 1 % of reading. Repeatability shall be greater than 0.25% of reading.

7. Accessories: Remote transmitter mounting bracket and interconnect cabling (include at least 30 feet of cable per flow meter – verify length with electrical contractor). Transmitter shall provide dry contacts or digital output when specified.

8. Mounting: Supplier shall mount transducer above flume's stilling well at a suitable height beyond the transmitter blanking distance. Transmitter shall be remotely mounted (2" pipe mounting bracket) from flume to provide local indication from an accessible location providing for routine maintenance.

9. Acceptable Manufacturers: ABB/Fischer & Porter, Siemens Automation (Milltronics Open Channel Meter OCM III or HydroRanger PLUS), Thermo Polysonics, or equal.

10. Instrument Schedule:

Instrument Tag Number	Design Flow	Flow Units	Weir / Flume Type	Area Classification	Notes

11. Notes:
    a. Submit instrument data sheet, instruction manual, installation guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.

c. Match flume flow transmitter calibration with associated flume design.

d. Provide visual level gauge beside flume inside manhole.

C. Flow Transmitter –Open Channel - Surface Radar

1. Type: Non-contact open channel flow measurement utilizing high frequency microwave doppler RADAR signal to determine the surface velocity of a fluid in an open channel with an ultrasonic level sensors to determine fluid height in the channel.

2. Design Criteria: Flow sensor shall be mounted above the normal maximum level of liquid in the channel. Flow sensor shall be rated for submerged operation with surcharge pressure sensor and surcharge electromagnetic sensor provided to supplement the integral ultrasonic level sensor and doppler radar sensor when it is reasonable and customary for the sensor to be flooded periodically (or level can go above the ultrasonic level transducer "blanking distance"). Flow meter to be supplied with all transducers, mounting hardware, cabling, remote transmitter, and all required accessories. Transmitter shall be microprocessor-based design that is designed to provide continuous self-diagnosis and shall provide linear output over the specified flow range. Volumetric flow measurement shall be calculated from surface radar flow signal (velocity) times measured liquid level using pre-programmed open channel geometry. Transmitter shall have provision to offset the level measurement (manual adjustment by plant maintenance) to compensate for sedimentation build-up over time. Transmitter shall have local display of level in Engineering Units. Transmitter shall be resistant to EMI/RFI interference. Transmitter shall be remotely mounted (2" pipe mounting bracket) in a non-hazardous location unless otherwise agreed upon with the Engineer. Typically used for open channel flow measurements where the degree of suspended solids over time would vary widely (limitation of ultrasonic doppler/transit time flow meters) and where there is significant possibility of trash in fluid stream causing damage to contact type flow measurements and where there is a sufficient possibility of sedimentation build-up prevent the proper operation of head type flowmeters (flumes or weirs).

3. Materials of Construction: Flow sensor enclosure shall be compatible (in case of submergence) with the process fluid in the open channel including potential dissolved gases or liquids. Metallic wetted parts to be made from 316 Stainless Steel or other material suitable for the operating environment and selected for compatibility with the process conditions and fluid. Mounting Hardware to be 316 Stainless Steel or other material suitable for the operating environment. Cable connection to the flow sensor connection shall be sealed and suitable for continuous operation in damp or occasionally low-level submerged service. Transmitter enclosure w/local Display to be NEMA 4X rated or as specified. Plastic/Polymer type transmitter enclosures located outdoors shall be coated with UV resistant coatings (provide Rain/Shield Shields as required). Complete flow meter installation including transducers and interconnect cabling shall be suitable for operation in the associated area classification.

4. Mounting: Flow sensor shall be mounted above the normal maximum level of liquid in the channel. Provide a Manhole to allow access to sensor and to allow sensor to be located above normal maximum liquid height in the open channel. Complete details of the intended transducer installation and interconnect wiring shall be submitted for approval prior to actual installation.

5. Transmitter Output: 4 – 20 ma Current Loop (analog output) (4 wire AC powered unless DC powered option agreed upon with the Engineer).

6. Accuracy: approximately +/- 5 of reading (over range of 0.75 fps to 20 fps).

7. Accessories: Flow Sensor and Remote Transmitter Mounting brackets and interconnect cabling– include at least 30 feet of cable per flow meter – verify length with electrical contractor). Transmitter shall provide pulsed DC or digital output when specified. Transmitter to be factory calibrated for bidirectional flow measurement as required. Sun and/or Rain Shields shall be provided for outdoor installations as required by Specification 13900.

8. Acceptable Manufacturers: Marsh McBurney (Flo-Dar) or equal.

9. Instrument Schedule:

Instrument Tag Number	Design Flow	Flow Units	Open Channel Dimensions	Area Classification	Notes
FE/FIT-110A	0 – 100	MGD	x feet wide x xx feet Deep with Sloped Section at bottom	Class 1 Division 1, Group D	a,b,c,d, e
FE/FIT-110B	0 – 100	MGD	x feet wide x xx feet Deep with Sloped Section at bottom	Class 1 Division 1, Group D	a,b,c,d,e

10. Notes:
    a. Submit flow meter sizing calculations with instrument data sheet, instruction manual, installation guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. Consult with vendor to determine upstream and downstream straight run requirements depending on open channel configuration.
    d. Include Surcharge Velocity Sensor
    e. Verify open channel dimensions with General Contractor prior to factory calibration of the transmitter. Provide step-by-step transmitter calibration setting sheet as part of the as-built installation submittal.

D. Flow Switch – Thermal

1. Type: Flow measurement that measures the amount of cooling that results then the fluid passes over a heated element. Temperature differential is proportional to the flow rate.

2. Design Criteria: Heater shall be customized for each specific application including whether fluid is liquid or gas. Typically used to detect loss of cooling water or ventilation failure.

3. Materials of Construction: Wetted parts shall be made from 316 SS or a material suitable for the process conditions and compatibility with the process fluid. Flow switch assembly to be rated NEMA 4X or as specified. Flow switch to be suitable for operation in the associated area classification.

4. Process Connections: 1" NPT.

5. Switch Contacts: Provide general-purpose snap action switches contacts - SPDT or DPDT as specified. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC.
6. Accuracy: Switching accuracy shall be +/- 0.5% of setpoint. Switching action shall be repeatable with /- 1 % of full-scale flow.
7. Accessories: Totalizer and/or transmitter, or remote mounting bracket when specified.
8. Mounting: Flow switches are inserted into smaller pipeline thru a threaded pipe "tee" or elbow. In larger lines, a threaded coupling is attached to the process piping. Flow switches must be orientated in the indicated direction of flow.
9. Acceptable Manufacturers: FCI, Static-O-Ring (T21 Series), or equal.
10. Instrument Schedule:

Instrument Tag Number	Flow Setting	Switch Contacts	Process Connection	Area Classification	Notes
FSL-415	Open @ 2000 SCFM Decreasing	SPDT	1" NPT	Class 1 Division 2	NONE
FSL-515A	Open @ 11,000 SCFM Decreasing	SPDT	1" NPT	Class 1 Division 2	NONE
FSL-515B	Open @ 11,000 SCFM Decreasing	SPDT	1" NPT	Class 1 Division 2	NONE

11. Notes:
    a. Submit flow meter data sheet, Instruction manual, Installation Guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. Consult with vendor to determine upstream and downstream straight run requirements depending on pipe arrangement.
    d. Confirm that heater size is suitable for fluid to be measured especially whether Liquid or Gas. Check for changes/fluctuations in heat capacity of the measured fluid.

E. Level Transmitter – Radar

1. Type: Level transmitter that uses the reflection of pulsed microwave energy off the surface of a liquid or powered solid to determine the height of the material in a vessel.
2. Design Criteria: Level transmitter shall be complete with radar antenna assembly, antenna mounting hardware, transmitter, or other accessories required for continuous operation during all environmental conditions. Guided Wave Radar should be used in place of pulsed wave radar when the measured fluid has low dielectric constant (< 2.0) or presence of foam (especially when it can coat the antenna on high liquid level) or for those applications where

excessive reflections could occur because of the number of objects in the vessel (ladders, agitators, pipes, etc). Transmitter shall be able to compensate for false or intermittent echoes while providing transducer failure or loss of signal alarming. Transmitter shall have local display of level in Engineering Units. Transmitter shall be resistant to EMI/RFI interference. Contractor shall supply FCC license where FCC Part 15 does not apply. Commonly used for non-contact liquid level measurements (works with some solids measurements) especially where ultrasonic measurement is inaccurate due to the presence of foam, dust, vessels under vacuum, etc. Works best when measuring slightly conductivity materials and those substances with a dielectric constant > 2.0 to guarantee strong fluid reflections that are accepted over false echoes. 4 wire transmitters have more pulses per second and are thereby preferred for difficult applications.

3. Materials of Construction: Mounting flange and transmitting rod/cone/guide wave shall be made from a material suitable for the process conditions and selected for compatibility with the process conditions and fluid. Provide Teflon coating if the flange/transmitter cone/rod materials or antenna seals are not compatible with the process fluid. Display/Transmitter enclosure to be NEMA 4X rated or as specified. Remote antenna assembly (if separate) and Transmitter to be suitable for operation in the associated area classification.

4. Process Connections: Threaded (typical for Guide Wave applications) or Flanged as required. Conventional pulsed radar antennas should be mounted above maximum liquid level at a suitable height beyond the transmitter's blanking distance. Complete details of the intended transmitter installation and interconnect wiring shall be submitted for approval prior to actual installation.

5. Transmitter Output: 4 – 20 ma Current Loop – provide HART Protocol or Foundation Fieldbus digital outputs when specified.

6. Accuracy: approximately +/- 0.1 inch. Repeatability shall be greater than 0.25% of reading.

7. Accessories: Remote display and interconnect cabling (include at least 30 feet of cable per level transmitter – verify length with electrical contractor) where specified. Transmitter shall provide digital output when specified.

8. Mounting: Supplier shall coordinate the transducer location to minimize false echoes from vessel walls and other obstructions in the path of the radar beam in accordance with the manufacturer's recommendations. When specified, Remote display may be required (2" pipe mounting bracket) to provide local indication from an accessible location.

9. Acceptable Manufacturers: Endress and Hauser, Krohne, Ohmart Vega, or equal.

10. Instrument Schedule:

Instrument Tag Number	Level Range	Level Units	Temperature Compensation	Area Classification	Notes
LIT201	0 – 39 Bottom El. 785 to top of concrete at 824 feet EL	Feet	YES	Class 1 Div. 1	Diversion Wet Well # 1 Level
LIT202	0 – 39 Bottom El. 785 to top of concrete at 824 feet EL	Feet	YES	Class 1 Div. 1	Diversion Wet Well # 1 Level
LIT301	0 – 39 Bottom El. 785 to top of concrete at 824 feet EL Weir xxx Ft	Feet	YES	Class 1 Div. 1	Diversion Wet Well # 2 Level
LIT302	0 – 39 Bottom El. 785 to top of concrete at 824 feet EL	Feet	YES	Class 1 Div. 1	Diversion Wet Well # 2 Level
LIT501	0 – 61 Bottom El. 796.5 to 1 foot above overflowr 856 Ft EL	Feet	YES	Class 1 Div. 1	Equalization Tank Level (note about 75 Feet from bottom of tank to nozzle on top of tank)

11. Notes:
    a. Submit instrument data sheet, instruction manual, installation details, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.

F. Level Transmitter – Ultrasonic

1. Type: Level transmitter that used the reflection of high frequency sound waves off the surface of a liquid or powered solid to determine the height of the material in a vessel.

2. Design Criteria: Level transmitter shall be complete with ultrasonic transducer, transducer mounting hardware, ambient air temperature compensation, freeze protection (if required), transmitter, or other accessories required for continuous operation during all environmental conditions. Transmitter shall be able to compensate for false or intermittent echoes while providing transducer failure or loss of signal alarming. Transmitter shall have local display

of level in Engineering Units. Transmitter shall be resistant to EMI/RFI interference. Commonly used for non-contact liquid level measurements. Typically used to measure the level of liquids or powered solids in bulk storage tanks – non-contact measurement for corrosive environments.

3. Materials of Construction: Transducer body to be made from thermoplastic or similar material suitable for operating conditions. Mounting hardware to be 316 Stainless Steel or other material suitable for the operating environment. Display/Transmitter enclosure to be NEMA 4X rated or as specified. Complete level transmitter installation including transducer, temperature elements (if provided), heaters (if provided), and transmitter shall be suitable for operation in the associated area classification(s).
4. Process Connections: Supplier shall mount transducer above maximum liquid level at a suitable height beyond the transmitter's blanking distance. Complete details of the intended transducer installation and interconnect wiring shall be submitted for approval prior to actual installation.
5. Transmitter Output: 4 – 20 ma Current Loop (analog output) and/or discrete contact closures as specified – provide HART Protocol or Foundation Fieldbus digital outputs when specified.
6. Accuracy: approximately +/- 0.25 % of full scale. Repeatability shall be greater than 0.1% of full scale.
7. Accessories: Remote transmitter mounting bracket and interconnect cabling (include at least 30 feet of cable per level transmitter – verify length with electrical contractor). Transmitter shall provide dry contacts or digital output when specified.
8. Mounting: Supplier shall mount transducer above maximum liquid level at a suitable height beyond the transmitter's blanking distance. Supplier shall coordinate the transducer location to minimize false echoes from vessel walls and other obstructions in the path of the ultrasonic beam from the transducer in accordance with the manufacturer's recommendations. Transmitter shall be remotely mounted (2" pipe mounting bracket) from transducer to provide local indication from an accessible location providing for routine maintenance.
9. Acceptable Manufacturers: ABB, Siemens Automation (Milltronics MultiRanger PLUS or HydroRanger PLUS), Endress and Hauser, Magnetrol, Ohmart Vega, or equal.
10. Instrument Schedule:

Instrument Tag Number	Level Range	Level Units	Mounting Method	Area Classification	Notes
LIT-120A	0 – 90	Inches	YES	Class 1 Division 1	A,B, C
LIT-120B	0 - 90	Inches	YES	Class 1 Division 1	A,B,C

11. Notes:
    a. Submit instrument data sheet, instruction manual, installation details, and dimensional drawing.

b. Provide stainless steel tag with Tag Number.

c. Remote Level Monitoring Manhole application requires very narrow beam angle ultrasonic sensor (about 6 degrees) in order to fit two level sensors in the same existing manhole without interference between the two level measurements.

G. Level Switch – Float

1. Type: Level switch that uses the buoyancy of a float attached to the level switch mechanism to detect a rising or falling level of liquid in a vessel. At a pre-set liquid level, this level switch shall close/open a set of contact(s) to generate an alarm or initiate a process action.

2. Design Criteria: Float activated switch mechanism. Float material shall be buoyant in the liquid to be measured including normal variations in the specific gravity of the measured fluid. Wetted parts of the switch mechanism shall be compatible with the process fluid including any dissolved gases – 316 SS default. Switch mechanical shall operate smoothly and reliably under all process conditions. Provide Bellows seal where required in particularly dirty environments. Switch module shall be hermetically sealed. Switching mechanisms using mercury shall not be provided. Float level switches are a cheap and reliable method of measuring the level of liquids in sumps or tanks. Provide intrinsic safety barriers where located in hazardous locations.

3. Switch Contacts: Provide SPDT or DPDT switch contacts as specified. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC. Provide hermetically sealed contacts unless otherwise specified.

4. Switch Setting and Reset Dead band: Provide information on switch set and reset movement requirements. Dead band to be approximately 1 inch or less.

5. Materials of Construction: All wetted parts to be 316 SS or material compatible with the process fluid. Switch enclosure to be NEMA 4X rated or as specified. The float switch provided shall be suitable for operation in the associated area classification; although, auxiliary means of protection may be provided in hazardous locations.

6. Mounting: Top (suspended) or mounted to a vertical 316SS support pipe mounting methods are acceptable. Mounting Hardware to be 316 SS unless otherwise specified. Complete details of the intended level switch installation and interconnect wiring shall be submitted for approval prior to actual installation.

7. Accessories: Hermetically sealed switch mechanism with integral cable where the level switch can be submerged. Cable shall be heavy-duty PVC jacket that is sealed to prevent moisture penetration into switch mechanism. Provide all mounting hardware.

8. Acceptable Manufacturers: Gems Sensor, Magnetrol, Static-O-Ring, or equal.

9. Instrument Schedule:

Instrument Tag Number	Setpoint	Level Units	Switch Type	Area Classification	Notes
LSL203	788.33 Falling	Ft Elev	SPDT	Class 1 Div 1	See D3-301, XX-YYYYY – Stop Pumps P-201, 202, 203
LSL204	785.8 Falling	Ft Elev	SPDT	Class 1 Div 1	See D3-301, XX-YYYYY – Stop Pump P-204
LSL303	788.33 Falling	Ft Elev	SPDT	Class 1 Div 1	See D3-301, XX-YYYYY – Stop Pumps P-301, 202, 203
LSL304	785.8 Falling	Ft Elev	SPDT	Class 1 Div 1	See D3-301, XX-YYYYY – Stop Pump P-304
LSHH205	807.8 Rising	Ft Elev	SPDT	Class 1 Div 2	See D3-301, Detail 3 D0-501
LSHH502	867 Rising	Ft Elev	SPDT	Class 1 Div 1	See CU-101, G0-106
LSHH503	787.8 Rising	Ft Elev	SPDT	Class 1 Div 2	See D7-306

10. Notes:
    a. Submit instrument data sheet, instruction manual, installation guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. For Hazardous Locations, provide Intrinsic Safety Barrier to be located in unclassified location.

H. Level Switch – Capacitance/RF Admittance

1. Type: Level switch that uses changes in measured capacitance or RF admittance to electronically actuate the level switch mechanism in response to rising or falling level of a liquid in a vessel. At a pre-set liquid level, this level switch shall close/open a set of contact(s) to generate an alarm or initiate a process action.
2. Design Criteria: Level switch assembly shall be complete with measuring electronics, sensor probe, reference electrode (where required), mounting hardware, junction boxes, or other accessories required for continuous operation during all environmental conditions. The sensing element shall be unaffected by coatings, foam, or other materials that may build up on the probe. Sensing probe and all wetted parts shall be compatible with the process fluid including any dissolved gases. Measuring electronics shall be hermetically sealed and resistant to EMI/RFI interference and suitable for the intended measuring environment. Provide FM approval certifications and intrinsic safety barriers where located in hazardous locations.
3. Switch Contacts: Provide SPDT or DPDT switch contacts as specified. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC. For DC circuits provide hermetically sealed contacts unless otherwise specified.

4. Switch Setting and Reset Dead band: Measuring accuracy shall be approximately 1% - provide information on measuring dead band and repeatability.

5. Materials of Construction: All wetted parts to be Teflon coated and/or 316 SS or material compatible with the process fluid. Switch enclosure to be NEMA 4X rated or as specified. The level switch provided shall be suitable for operation in the associated area classification; although, auxiliary means of protection may be provided in hazardous locations.

6. Process Connection: Typically Top or Side of Vessel mounted by attachment to ¾ inch or 1 inch threaded connections or flanged mounted to a nozzle attached to the vessel. Complete details of the intended level switch installation and interconnect wiring shall be submitted for approval prior to actual installation.

7. Accessories: Provide remote level switch electronics enclosure and sensor interconnecting cabling where required. Provide all mounting hardware.

8. Acceptable Manufacturers: Magnetrol, Drexelbrooke, or equal.

9. Instrument Schedule:

Instrument Tag Number	Setpoint	Level Units	Switch Type	Area Classification	Notes
LSH501	855 Rising	Ft Elev	DPDT	Class 1 Div1	See D8-102, 301
LSHH501	855.5 Rising	Ft Elev	DPDT	Class 1 Div 1	See D8-102, 301

10. Notes:
    a. Submit instrument data sheet, instruction manual, installation guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. Level Switch shall be FM approved for Hazardous Area Locations as noted above. Provide Intrinsic Safety Barrier to be located in unclassified location (PLC I/O Cabinet inside Electrical Room).

I. Pressure Switch with Diaphragm Seal

1. Type: Pressure sensing switch that has inlet pressure port connected to a metal diaphragm that opposes an adjustable spring. At a pre-set amount of the inlet pressure the diaphragm actuator overcomes the spring tension and operates an attached mechanical switch assembly to close/open a set of contact(s) to generate an alarm or to initiate a process action.

2. Design Criteria: Diaphragm style switch actuator with a single pressure sensing port. Diaphragm and switch mechanism must be able to withstand the maximum process pressure on the inlet port. Wetted parts suitable for process fluid – 316 SS default. Typically used for normal process gage pressure monitoring applications. Can be used with a Diaphragm seal to measure pressure on process fluids that might otherwise plug the pressure sensing port or to allow for less exotic wet parts on the pressure switch itself.

3. Process Connections: ½" NPT (default) or ¼" NPT as specified. 1 inch NPT or saddle seal mounting to be provided for pressure switch applications where diaphragm seals are specified.

4. Switch Contacts: Provide SPDT or DPDT switch contacts as specified. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be

made from silver or gold rated for 5 Amps at 125 VDC. Provide hermetically sealed contacts as specified.

5. Switch Setting and Reset Deadband: Single (default) or dual adjustable setpoint(s) with fixed (default) or adjustable deadband. Switch setpoint should be approximately 60% of the nominal differential pressure range provided.

6. Materials of Construction: All wetted parts to be 316 SS or material compatible with the process fluid. Diaphragm to be 316SS with viton o-ring unless other materials are required for process compatibility. Teflon coated metal diaphragms are only acceptable where the process fluid temperature will not damage the coating or affect the free movement of the diaphragm. Switch enclosure to be NEMA 4X rated or as specified. The pressure switch to be suitable for operation in the associated area classification.

7. Mounting: Remote mounted to be provided with 2 inch pipe stand Mounting Bracket. Mounting Hardware to be 316 SS unless otherwise specified. Pressure Switches with integral diaphragm seals can be process mounted via the diaphragm seal where process vibrations would not impede the proper operation of the pressure switch.

8. Accessories: Provide diaphragm seals where required for liquids with entrained solids or corrosive applications, as specified.

9. Acceptable Manufacturers: Dresser Industries (Ashcroft), Static-O-Ring, or equal.

10. Instrument Schedule:

Instrument Tag Number	Set point	Proces Conn.	Diaphragm Material	Switch Type	Area Classification	Notes
PSH-501	15 PSIG Rising	1" NPT	316 SS	SPDT	Class 1, Division 1	Provide Diaphragm Seal
PSH-502	15 PSIG Rising	1" NPT	316 SS	SPDT	Class 1, Division 1	Provide Diaphragm Seal

11. Notes:
    a. Submit switch data sheet, Operation and Maintenance manual, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. Provide diaphragm seals, where specified.

2.02 ANALYTICAL EQUIPMENT

A. Combustible Gas Detector

1. Type: Analytical transmitter that is calibrated to measure the lower explosion limit of the measured fluid or gas. Infrared gas detection is preferred over catalytic bead to minimize the frequency of recalibrations.

2. Design Criteria: Combustible Gas Detection system shall be complete with sensor(s), sensor to transmitter interconnecting wiring, mounting hardware, junction boxes, or other accessories required for continuous operation during all environmental conditions. Sensor supplied shall be compatible with the process fluid including any dissolved gases. Transmitter shall be resistant to EMI/RFI interference and suitable for the intended

measuring environment. Transmitter shall have automatic temperature compensation over the full operating temperature range of the measured process fluid. Multiple sensor transmitters are acceptable as long as individual sensor alarming is available where required. Provide FM approval certifications and intrinsic safety barriers where sensors and/or transmitters are located in hazardous locations. Where measurements for Gas Detection are inside pressurized (positive or negative pressure relative to atmosphere), provide sampling systems and associated controls required to guarantee a continuous and reliable measurement.

3. Sensor/Transmitter Accuracy: approximately +/- 3% of full scale. Zero drift less than 5% per year, Span drift less than 10% per year..
4. Transmitter Output: 4-20 ma DC Output plus Switch Output as noted in Schedule - SPDT or DPDT switch output at adjustable setting
5. Switch Contacts: Provide SPDT or DPDT switch contacts as specified. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC.
6. Switch Setting and Reset Dead band: Provide information on adjustability (including method of making field changes) of switch ON and RESET settings available with device to be supplied. Default dead band shall be 5% of full scale.
7. Materials of Construction: All wetted parts to be 316 SS or material compatible with the process fluid. Sensor and Transmitter housing to be NEMA 4X rated or as specified. The Combustible Gas Detection system provided shall be suitable for operation in the associated area classification; although, auxiliary means of protection may be provided in hazardous locations.
8. Mounting: Sensors shall be 2" pipe stand or wall mounted or other method as appropriate. Mounting Hardware to be 316 SS unless otherwise specified. Complete details of the intended sensor installation and interconnect wiring shall be submitted for approval prior to actual installation.
9. Accessories: One extra sensor for each installation, mounting hardware, and any accessories as appropriate for installation. Provide sufficient cable length to reach below minimum liquid level and to connect to signal junction box – verify length with electrical contractor. Provide supplies required for period recalibration of all analyzers provided for the 1st year of operation. Transmitter shall provide analog or contact outputs as required.
10. Acceptable Manufacturers: MSA (Ultima X), Draegar, or equal.
11. Instrument Schedule:

Instrument Tag Number	Measurement Range	Reference Fluid	Switch Output	Location	Area Classification	Notes
AIT210	0-100% LEL	Methane	SPDT	Outdoors	Class 1 Div 1	a,b,c,d,e,f,g
AIT212	0-100% LEL	Petroleum	SPDT	Outdoors	Class 1 Div 1	a,b,c,d,e,f,g
AIT310	0-100% LEL	Methane	SPDT	Outdoors	Class 1 Div 1	a,b,c,d,e,f,g
AIT312	0-100% LEL	Petroleum	SPDT	Outdoors	Class 1 Div 1	a,b,c,d,e,f,g
AIT411	0-100% LEL	Methane	SPDT	Outdoors	Class 1 Div 1	a,b,c,d,e,f
AIT511	0-100% LEL	Methane	SPDT	Outdoors	Class 1 Div 1	a,b,c,d,e,f

12. Notes:
    a. Submit instrument data sheet, instruction manual, installation guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. Combustible Gas Detection Sensor and/or Transmitter shall be FM approved for Hazardous Area Locations as noted above. When any part of the analyzer is located in a hazardous area, provide an Intrinsic Safety Barrier to be located in unclassified location.
    d. Provide supplies required for period recalibration of all analyzers provided for the 1st year of operation.
    e. Transmitter to be located in remote location in Electrical Room outside of Hazardous Area
    f. Design sensor to operate in an atmosphere of 100 ppm of hydrogen sulfide for up to 24 hours with no more than 5% reduction in sensor response time.
    g. Provide Sampling System with sample pump – low flow/pump failure alarming

B. Hydrogen Sulfide Gas Detector

1. Type: Analytical transmitter that is calibrated to measure the concentration of hydrogen sulfide in the ambient air.
2. Design Criteria: Hydrogen Sulfide Gas Detection system shall be complete with sensor(s), sensor to transmitter interconnecting wiring, mounting hardware, junction boxes, or other accessories required for continuous operation during all environmental conditions. Sensor supplied shall be compatible with the process fluid including any dissolved gases. Transmitter shall be resistant to EMI/RFI interference and suitable for the intended measuring environment. Transmitter shall have automatic temperature compensation over the full operating temperature range of the measured process fluid. Multiple sensor transmitters are acceptable as long as individual sensor alarming is available where required. Provide FM approval certifications and intrinsic safety barriers where sensors and/or transmitters are located in hazardous locations. Where measurements for Gas Detection are inside pressurized (positive or negative pressure relative to atmosphere), provide sampling systems and associated controls required to guarantee a continuous and reliable measurement.
3. Sensor/Transmitter Accuracy: approximately +/- 3% of full scale. Zero drift less than 5% per year, Span drift less than 10% per year.
4. Transmitter Output: 4-20 ma DC Output – provide Switch Output if noted in Schedule (either SPDT or DPDT switch output at adjustable setting as noted).
5. Switch Contacts: Provide SPDT or DPDT switch contacts as specified. Contacts for 120VAC circuits to be rated for 10 amps at 120 VAC. Contacts for DC circuits shall be made from silver or gold rated for 5 Amps at 125 VDC.
6. Switch Setting and Reset Dead band: Provide information on adjustability (including method of making field changes) of switch ON and RESET settings available with device to be supplied. Default dead band shall be 5% of full scale.
7. Materials of Construction: All wetted parts to be 316 SS or material compatible with the process fluid. Sensor and Transmitter housing to be NEMA 4X rated or as specified.
8. Mounting: Sensors shall be 2" pipe stand or wall mounted or other method as appropriate.

Mounting Hardware to be 316 SS unless otherwise specified. Complete details of the intended sensor installation and interconnect wiring shall be submitted for approval prior to actual installation.

9. Accessories: One extra sensor for each installation, mounting hardware, and any accessories as appropriate for installation. Provide sufficient cable length to reach below minimum liquid level and to connect to signal junction box – verify length with electrical contractor. Provide supplies required for period recalibration of all analyzers provided for the 1st year of operation. Transmitter shall provide analog or contact outputs as required.
10. Acceptable Manufacturers: MSA (Ultima X), Draegar, Sensidyne, or equal.
11. Instrument Schedule:

Instrument Tag Number	Measurement Range	Reference Fluid	Switch Output	Location	Area Classification	Notes
AIT211	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 1	a,b,c,d,e,f,g
AIT311	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 1	a,b,c,d,e,f,g
AIT410	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 2	a,b,c,d,e,f,g
AIT412	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 2	a,b,c,d,e,f,g
AIT413	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 2	a,b,c,d,e,f,g
AIT510	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 2	a,b,c,d,e,f,g
AIT512	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 2	a,b,c,d,e,f,g
AIT513	0 – 30 PPM	H2S	4-20 ma Only	Outdoor	Class 1 Div 2	a,b,c,d,e,f,g

12. Notes:
    a. Submit instrument data sheet, instruction manual, installation guidelines, and dimensional drawing.
    b. Provide stainless steel tag with Tag Number.
    c. Hydrogen Sulfide Sensor and/or Transmitter shall be FM approved for Hazardous Area Locations as noted above. When any part of the analyzer is located in a hazardous area, provide an Intrinsic Safety Barrier to be located in unclassified location.
    d. Provide supplies required for period recalibration of all analyzers provided for the 1st year of operation.
    e. Transmitter to be located in remote location in Electrical Room outside of Hazardous Area
    f. Design sensor to operate in an atmosphere of 100 ppm of hydrogen sulfide for up to 24 hours with no more than 5% reduction in sensor response time.
    g. Provide Sampling System with sample pump – low flow/pump failure alarming

2.03 PANEL MOUNTED INSTRUMENTS

A. Panel Meter (Vertical Bar Graph Indicator)

1. Type: Electronic indicator, vertical bar graph type. Single or Dual display as required, multi-segmented gas discharge tube.
2. Display: High Visibility vertical multi-segmented bar graph, display the input measurement in Engineering Units.
3. Input: 4-20 ma DC or as specified below. Input Impedance to be less than 100 ohms.
4. Accuracy: Plus or minus 0.5 percent.
5. Power Supply: 120 VAC
6. Mounting - Flush panel mounting, provide gasket kit when mounting on NEMA 12 or NEMA 4/4X Control panel. Display enclosure shall match the environmental rating of the Control Panel.
7. Acceptable Manufacturers: Foxboro, Omega Engineering, or equal.
8. Notes:
   a. Provide Loop Power for field instrument when noted.

B. Panel Meter/Indicator (Digital Display)

1. Type: Electronic indicator, LED numeric display of single analog measurement.
2. Display: High Visibility Red (unless other color is noted below) LED display, provide at least 3-1/2 numeric digits, numeric display to be minimum ½ inch in height, field select selectable decimal point. Display the input measurement in Engineering Units. Display shall indicate over-range input.
3. Input: 4-20 ma DC or as specified below. Input Impedance to be less than 100 ohms.
4. Accuracy: Plus or minus 0.1 percent.
5. Power Supply: 24V DC or 120 VAC as required.
6. Mounting - Flush panel mounting, provide gasket kit when mounting on NEMA 12 or NEMA 4/4X Control panel. Display enclosure shall match the environmental rating of the Control Panel.
7. Acceptable Manufacturers: Action Instrument (Visipak Series), Foxboro (model 710), Newport, Red Lion, or equal.
8. Notes:
   a. Provide Loop Power for field instrument when noted.
   b. Provide two alarm contact outputs – Form C – rated at 5 amps at 120 VAC when noted.
   c. Provide Input Repeat Option, Output to be 4-20ma DC when noted.
   d. Provide hardcopy of any special alarm or signal conditioning configurations.

C. Electronic Single-Station Analog Controller

1. Type: Microprocessor based configurable Electronic analog Controller capable of acting as single or cascade loop controller.

2. Controller Configuration Options (Minimum requirements):
   a. Capable of Proportional (P Only), Proportional – Integral (PI Control), or Proportion – Integral – Derivative (PID Control) controller modes as required (field configurable)
   b. Single or Cascade (two measurement, one or two outputs) controller operation.
   c. Ability of controller to act as a differential gap controller (setpoint deviation control).
   d. Ability to provide adaptive gain control.
   e. Ability of use one or more of the inputs to implement ratio control.
   f. Ability to act as a Manual Loader (operator adjustable output).
   g. Input signal conditioning (biasing, square root, etc).
   h. Integral Mode shall include Anti-reset windup calculations.
   i. Bumpless transfer from/to Manual/Auto/Cascade Controller modes.
   j. Ability to use of one of the inputs as the controller remote setpoint.
   k. Ability to choose local/remote setpoint or auto/manual control from remote location or locally at controller.
   l. Provides indication of local/remote and auto/manual switch status.
   m. Ability to provide limit rate of change of Outputs or to provide high and low limits for controller outputs.
   n. Ability to set controllers for direct or reverse controller action.
   o. Absolute and Deviation Alarming of inputs. Absolute alarming of setpoints and outputs.
3. Display: Front Display of process measurement, setpoints, and controller outputs. Display of the input and setpoints to be in Engineering Units. Display shall indicate over-range of inputs and outputs.
4. Analog Inputs: 4-20 ma DC or 1-5 V DC. Minimum of two inputs required. Input Impedance to be 250 ohms maximum.
5. Analog Outputs: 4-20 ma DC. Minimum of two inputs required. Ability to drive up to 800 ohms maximum.
6. Discrete Inputs: Minimum of two inputs required.
7. Discrete Outputs: Minimum of two inputs required.
8. Input Accuracy: Plus or minus 0.1 percent of span.
9. Output Signal Accuracy: Plus or minus 0.2 percent of span.
10. Power Supply: 120 VAC or 24 VDC as required.
11. Mounting – Flush panel mounting. Enclosure shall match the environmental rating of the Control Panel.
12. Acceptable Manufacturers: ABB, Action Instrument, Foxboro (Models 761/762), Honeywell (UDC Series), Newport, Siemens Automation (Moore Products -Model 353), or equal.
13. Notes:
   a. Inputs can be individually selectable for loop or externally powered.
   b. Factory pre-configuration option available.
   c. Provide hardcopy of each controller's configuration.
   d. RS-232 or RS-485 interfaces for programming or communications.

D. Indicating Control Station

1. Type
   a. Electronic input and output.
2. Functional/Performance
   a. Operation - Provides a standard electronic setpoint signal to a remote controller or other equipment based on a manual or an automatic (remote) setting. Where indicated in Contract Documents, provide the following capabilities: bias adjustment (+/- 100% of signal), signal tracking.
   b. Input/Output - Microprocessor-based; Input - 4-20 mADC into 250 ohms (max); Output - 4-20 mADC into 640 ohms (min).
   c. Indication - LED Indication - Input and output values and manual/auto mode.
   d. Control - Touch-pad switches: selection of manual/auto modes and manual output setting.
   e. Bumpless, balanceless transfer.
   f. Accuracy - Plus or minus 0.5 percent of span.
3. Physical
   a. Case - Nominal 3 in. wide by 6 in. high by 20 in. deep, General Purpose Enclosure.
   b. Mounting - Flush panel or surface mount, suitable for high density mounting arrangement.
4. Manufacturer
   a. Moore Products
   b. Or equal.

E. Signal Relay Switches (Current Trips)

1. Type
   a. Solid state electronic type.
2. Functional/Performance
   a. Input - 4-20 mA
   b. Output - Isolated contact output, double pole double throw, rated 5 Amps at 120 VAC.
   c. Accuracy - 0.1 percent.
   d. Protection - Provide RFI protection.
   e. Deadband - Adjustable between 0.1 and 5.0 percent of span.
   f. Setpoint Adjustment - Provide graduated dial for each alarm set point from 0 to full scale. Alarms shall be adjustable to trip on rising or falling input signal.
   g. Repeatability – Trip point repeatability shall be at least 0.1 percent of span.
3. Physical
   a. Mounting - Suitable for mounting in an enclosure or high density instrument rack.
4. Options/Accessories Required
   a. Mounting rack or general purpose enclosure as required.

5. Manufacturers
   a. Rochester Instrument Systems
   b. Acromag Inc.
   c. Moore Industries

F. Signal Isolators/Boosters/Converters

1. Type
   a. Solid state electronic type.
2. Functional/Performance
   a. Accuracy - 0.15 percent.
   b. Inputs - Current, voltage, frequency, temperature, or resistance as required.
   c. Outputs - Current or voltage as required.
   d. Isolation - There shall be complete isolation between input Circuitry, output circuitry, and the power supply.
   e. Adjustments - Zero and span adjustment shall be provided.
   f. Protection - Provide RFI protection.
3. Physical
   a. Mounting - Suitable for mounting in an enclosure or instrument rack.
4. Options/Accessories Required
   a. Mounting rack or general purpose enclosure as required.
5. Manufacturers
   a. Rochester Instrument Systems
   b. Acromag Inc.
   c. Moore Industries

G. Signal Selectors, Computation, and Conditioning Relays

1. Type
   a. Solid state electronic type.
2. Functional/Performance
   a. Inputs - 4-20 mA
   b. Outputs - 4-20 mA
   c. Protection - Provide RFI protection.
   d. Operation - The relay shall multiply, add, subtract, select, extract the square root, or perform the specified conditioning/computation function required. All inputs shall be able to be individually rescaled and biased as required.
   e. Isolation - All inputs, outputs, and power supplies shall be completely isolated.
   f. Accuracy - 0.35 percent of span.
   g. Adjustments - Multiturn potentiometer for zero, span, scaling, and biasing.
3. Physical
   a. Mounting - Suitable for mounting in an enclosure or instrument rack.
4. Options/Accessories Required
   a. Mounting rack or general purpose enclosure as required.

5. Manufacturers
   a. Rochester Instrument Systems
   b. Acromag Inc.
   c. Moore Industries

H. Intrinsic Safety Relays

1. Type: Specialty solid state protective relay to insure that the energy level associated with an electric circuit connecting thru a electrically "hazardous" area is always below the explosive limit of any potentially flammable gases or liquids that might be present in the area.

2. Design Criteria: Intrinsic Safety Relays shall be located in non-hazardous areas and shall be designed to provide personnel and equipment protection in accordance with National Electrical Code. See Contract Specification 17000 Section 2.03. Intrinsic Safety Relays shall be designed specifically for each individual circuit to be protected and shall be compatible with the circuit voltage and entity parameters of instrumentation and associated devices that are part of that circuit. Circuit Design Calculations to be submitted with each Intrinsic Safety Relay to be utilized.

3. Certification: Each Intrinsic Safety Relay to be certified by FM and UL as suitable for providing an auxiliary means of protection for the associated apparatus located in the specified electrically hazardous area classification associated with the electric circuit to be protected. Provide a copy of the Certification Information with each submittal.

4. Panel Mounting: Surface Mount or "DIN" style mounting rail.

5. Enclosure: Manufacturer Standard. Provide screw type wiring terminals.

6. Acceptable Manufacturers: Gems Sensor, MTL, Pepperl Fuchs, R Stahl, Turck, or equal.

I. Uninterruptable Power Supplies (UPS)

1. Type: Battery backup type power supply for computer type systems that utilizes sealed no-maintenance type batteries and a inverter to convert DC power from the attached batteries to generate a AC true-sinusoidal power output to power attached devices should the incoming AC power source be interrupted for any reason. An included AC powered charger insures that the attached batteries are keep fully charged at rated voltage when the UPS is "on standby" monitoring the condition of the incoming AC power source for possible lose of feed.

2. Design Criteria: UPS systems shall be an on-line, computer-grade system. Transfer to battery power shall be instantaneous with no transfer time. Unit shall consist of charger, batteries, inverter unit, on-line ferroresonant transformer for complete line isolation, synchronizing equipment, protective devices (include surge protection on line side), and accessories required to provide regulated, uninterruptable electrical power to the protected device or devices. Units shall include all mechanical and electrical devices that will provide continuity of electrical power within specified tolerances without interruption upon failure or deterioration of the primary power. Use of static transfer switch shall be required as noted on the drawings to allow for maintenance.

3. Sizing: Units shall be sized to provide at least 30 minutes of full load backup power for all attached rated loads. Additionally units shall be sized to provide a minimum of 25 percent unused capacity after full load calculations.

4. Electrical Characteristics:

a. Input:
   i) Voltage : 115 VAC, +- 10%
   ii) Frequency: 57 to 63 Hz

b. Output:
   i) Voltage: 115 VAC +/- 3%
   ii) Frequency: Synchronized to ac input line when on ac operation. When on batteries frequency shall be 60 Hz +/- .5%.
   iii) Harmonic Content: Maximum 5% total harmonic distortion.

5. Status and Alarm Contacts: Manufacturer Standard. Provide screw type wiring terminals.
   a. Auxiliary contacts (SPDT) and all wiring and connections shall be provided for remote indication of the following UPS conditions:
      i) Main Power "On" Status (On/Off)
      ii) Inverter "On" Status (On/Off)
      iii) Battery Power "On" Status (On/Off)
      iv) UPS Trouble Alarm (Failure of UPS)

6. Accessories: Bypass Switches: A Bypass Switch shall be provided to manually bypass the UPS for Maintenance purposes. During bypass operation, the outlet load shall be directly connected to the primary power source..

7. Acceptable Manufacturers: Best Power Technology, Inc.; Tripp Lite; Liebert; or equal.

2.04 MAINTENANCE REQUIREMENTS

A. To permit operation during the warranty period – supplier shall provide One year supply of any reagents/consumables as listed by the manufacturer as required for the first year of normal operation or scheduled routine maintenance for each device provided under this specification.

B. In addition to the tools and test equipment specified elsewhere in the Contract Specifications, provide additional spare parts as specified in the individual device specifications.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Instrumentation and Controls supplied under this section shall be installed per the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions", Division 13 Contract Specification 13270 – "Surge and Lightning Protection", and Division 13 Contract Specification 13900 "Instrumentation Installation Guidelines".

B. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of instrumentation and controls work and in case of any interference with other work, proceed as directed by the

Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

C. Instrumentation and Controls furnished under this specification shall be factory and/or "bench" calibrated prior to installation and testing.

D. Unless specifically shown in the Contract Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or pipe stands. All instrumentation process and instrument air connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing, and blow down service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

E. Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged units or systems shall remain on site and returned to the manufacturer after the replacement units or systems have been delivered to the site. Under no circumstances will instrumentation or controls equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied, and all costs associated with replacement shall be borne by the Contractor.

F. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer. The entire damaged enclosure panel or section shall be repainted per the field painting specification Section 09902, at no additional cost to the Owner.

3.02 INSPECTION AND TESTING

A. Instrumentation and Controls supplied under this section shall be inspected and tested per the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions" and Division 13 Contract Specification 13270 – "Surge and Lightning Protection".

B. Test all instrumentation and control system components furnished under this Specification and repair or replace all defective equipment or work. Make all necessary adjustments and instruct the Owner's personnel in the proper operation of the instrumentation and controls provided.

C. Test grounding and verify any other safe operation concerns associated with all supplied control panels, PLC hardware, intrinsic safety equipment, and other sensitive electrical or electronic control system equipment prior to energization. Supplier shall certify that the grounding and installation is in conformance with the manufacturer's warranty requirements prior to providing temporary or permanent power to any supplied equipment. Submit copies of certified installation and grounding test reports.

3.03 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

3.04 TRAINING

A. Instrumentation and Controls supplied under this section shall be incorporated in the overall training plan as required by the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions".

END OF SECTION 13300

SECTION 13400
PROGRAMMABLE CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The provisions and requirements of Division 13, Section 13000 "General Provisions" of this Specification shall apply to the work specified in this section.

C. Work associated with the furnishing and fabricating of control panels associated with this Specification shall be as specified in Division 13, Section 13200 "Control Panels".

D. Programmable Controllers and associates components furnished under this Specification shall be provided with transient surge and lightning protection as required in Division 13 Contract Specification 13270 "Surge and Lightning Protection".

1.02 SUMMARY

A. This Section defines the requirements for the design, supply, assembly, configuration, testing, and delivery of programmable logic controllers (PLCs) associated with instrumentation and control system that are not provided under other sections of the Contract and as necessary to complete the instrumentation and controls as shown on the Contract Drawings and Contract Specifications.

B. Furnish all labor, engineering design including programming, supervision, materials, equipment, and incidentals required to complete and ready for operation, said programmable controller based process control system as depicted on the Contract Drawings or on the P&ID's or as listed on the PLC I/O List. Unless otherwise noted, the field installation of all programmable controller hardware, control panels, and/or I/O Cabinets furnished under this Specification shall be performed by the General Contractor and/or Electrical Contractor. The party responsible for the design and configuration of the programmable controller based control system shall be responsible to certify the proper installation and operation of all supplied equipment.

C. All the Work in this Section shall be the sole responsibility of the designer of the programmable controller based process control. Components and enclosures may be provided by other suppliers and/or manufacturers, but the integration, coordination, packaging, wiring and testing of these components and the production of the final product shall conform to this specification and shall be the sole responsibility of the programmable controller based control system designer.

D. Programmable Controllers provided under this Section shall include the following:

1. Diversion FacilityPLC (Programmable Controller) to be located in the Diversion Facility Electrical Building Local Control Panel PLC-101.
2. Equalizaton Facility PLC (Programmable Controller) to be located in the Equalization Facility Electrical Building Local Control Panel PLC-201.

3. Remote Telemetry PLC to be located in a RTU Local Control Panel LCP-120 at the existing Level Monitoring Manhole located near the Cross Creek Housing Area. (this manhole is also referred to as the Peachtree Creek Trunk Relief Manhole (PCTRM) MH 23180203601)

1.03 TERMINOLOGY

1. PLC: Programmable Logic Controller. Can refer to the processor alone or to a system including processor, I/O racks, and Input / Output cards. Often shorted to be "Programmable Controller".
2. I/O: Input / Output. Input designates information sent to the processor from connected devices; Output designates information being sent to connected devices from the processor. The information referred to may be binary (on / off signals), analog, or encoded serial or parallel data.
3. Data Highway: Used in a generic sense to refer to any of the several supplier specific data communication links used to allow data transfer between 2 or more PLCs or other intelligent devices.
4. Scan Time: Time required to read all inputs, execute the control program, and update local and remote I/O. With today's technology specifications for permissible scan times can be complicated due to the fact that some PLCs allow organization of the program logic such that parts of the program may execute more frequently than others. Likewise, some processors permit some I/O to be updated more frequently than others. For purpose of this specification Scan Time refers to the maximum overall scan time.
5. MMI: Man - Machine Interface - The software/procedure that allows the operator to interact with the control system to set controller set points, controller modes, start/stop motors or verify the operational status of the process as monitored by the control system. The interface can be in form of graphical pictures with constantly updating process data, traditional controller type "faceplate" displays, graphical representations of trend or strip chart recorders or text only status or alarm "pages". Used in a generic sense refers to the software or philosophy used to interface the operator to the control system.
6. OIT: Operator Interface Terminal - a device that allows the operator to control or monitor a control system that is usually connected to a manufacturing process similar to MMI above. Specially refers to the hardware used to perform the MMI function. Terms are often used interchangeability when discussing the concept but have different specific intents.
7. Virtual I/O: discrete or analog information both of input or output nature that is communicated to the programmable controller over a non-physical virtual communication link from a remote vendor furnished control system to the project's control system.
8. For a more comprehensive list of applicable terminology and their conventional meanings, refer to IEEE (Institute of Electrical and Electronics Engineers) Standard 100-1984, Dictionary of Electrical & Electronics Terms.

1.04 REFERENCE STANDARDS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Reference Standards" and as specified herein.

1.05 QUALITY ASSURANCE

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Quality Assurance" and as specified herein.

1.06 SUBMITTALS

A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Construction Manager shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. In accordance with the General Conditions and the Special Conditions of the Contract and with Contract Specification 13000, submit to the Engineer the following documentation to demonstration compliance with submittal requirements of the Contract:

C. Shop drawings including copies of all drawings, parts lists, product data, and other materials shall be submitted and shall include:

1. List of all new Programmable Controllers, I/O Modules, Control Panels, and I/O Cabinets and/or new sub-panels associated with existing Control Panels to be furnished.
2. Definition of all rework to be performed on existing programmable controllers and/or I/O Cabinets including PLC or Cabinet name, location, and general description of work to be done in each programmable controller or I/O Cabinet.
3. PLC System Architecture Drawings showing all Programmable Controllers to be furnished, modified, and otherwise interconnected to the work being performed under this Specification.
4. General Arrangement (GA) drawing(s) of all new or modified Control Panels and I/O Cabinets. GAs shall include outline, dimensions, and estimated weight for each panel or cabinet.
5. Complete Identified Bill of Materials for each Programmable Controller, Control Panel, or I/O Cabinet. Bill of Materials shall reference General Arrangement drawing(s) and shall include ID #, manufacturer, model number, description, and quantity for each item.
6. Complete Identified component list of programmable controller hardware and software including all processors, programming software, memory modules, I/O Chassis, Power Supplies, Cables, interface hardware, and I/O Modules to be furnished.
7. Project specific identified product data sheets for each component in the Bill(s) of Materials and components list(s).

8. Interconnect wiring drawings for all internal panel or cabinet wiring. Interconnect drawings shall identify all terminal strips, wiring, and devices located inside the panel and shall note where external connections shall be made.

9. Where available, provide manufacturer instruction manuals containing manufacturer installation and maintenance requirements and troubleshooting guide.

10. PLC I/O Lists including all Real World and Virtual I/O Points. Where Virtual Communication Links are required – PLC Hardware submittal shall include all PLC communication gateways and details on the required data highway type communication links and interface connections to the remote non-Division 13 control systems. Similarly where Virtual Communication Links are required – PLC Software submittal shall include Virtual I/O lists and Virtual I/O addressing and project specific information on each required Virtual communication link as to the type of communication protocol being proposed, complete listing of all virtual I/O points available in each interfaced device, vendor specific internal address scheme, and the recommended/required points being proposed to be communicated over each Virtual I/O Link.Complete commented list of each programmable controller's program including Cross-Reference Table utilizing an approved, commercially available personal computer based PLC Programming development system.

11. Complete list of Spare Parts, Expendables, and Test Equipment to be provided.

D. After Fabrication, Installation, and Testing are complete and approved, Submit Record Documents per Contract Specification 13000 Section "Record Drawings".

E. After Record Drawings have been approved, submit Operation and Maintenance Manuals per Contract Specification 13000 Section "Operation and Maintenance Manuals".

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery, Identification, Storage and Handling of all supplied programmable controller hardware and software shall be in full conformance with the Contract Specifications and with Division 13 Contract Specification 13000 Section "Delivery, Storage, and Handling" and as specified herein.

B. Control Panels and I/O Cabinets shall be mounted on wooden skids at least four inches high suitable for movement via forklift truck. Control Panels and Cabinets shall be suitably wrapped or crated depending on the distance to be traveled and the amount of transfers to be made during shipment from point of origin to point of actual installation.

C. Control Panels and I/O Cabinets shall be only shipped via Air-Ride Van.

D. Control Panels and I/O Cabinets shall not be stored out-of-doors even if designed for outdoor installation until temporary or permanent sun and rain shields have been erected at the installation or storage location (assuming the enclosure is rating for outdoor installation).

E. Instruments and control devices inside control panels or cabinets shall be "blocked" and "tied off" to prevent damage during shipment. Front of panel instruments shall be removed and re-packed in their original containers for shipment. Similarly, all Control System processors, I/O Cards, and other sensitive electronic equipment shall be removed and re-packed in their original containers for shipment. All removed instruments and controls shall be properly labeled to facilitate re-assembly at the jobsite.

F. All programmable hardware and software shall BE stored in dry, permanent type indoor shelters. All storage locations shall be indoors with temperature and humidity controls per the manufacture's instructions and shall be adequately protected against mechanical injury. If any equipment has been damaged, such damage shall be replaced by the Contractor at his own cost and expense. Project delay costs associated with improper storage or replacement delays shall be the sole responsibility of the supplier and/or Contractor.

G. All mounting hardware, accessories, and at least one set of drawings and instruction manuals necessary to complete the field installation shall be shipped with the Programmable Controller Shipment.

1.08 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passing through such restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.09 WARRANTY

A. Provide a warranty for all programmable controller hardware and software in accordance with the general requirements of the Contract Specifications. Unless specified more stringently elsewhere in the general requirements, the components of the programmable controller system shall be warranted against defective materials, design, and workmanship for a period of one (1) year from the date of final acceptance.

B. During the warranty period, the Supplier shall furnish personnel to inspect, test, and take corrective action to correct all deficiencies in his "Scope of Work" such that the corrective action is consistent with the quality of materials and work of the original construction and is in conformance with the Contract Specifications, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Programmable Logic Controllers (PLCs) as defined in this Specification shall be provided to perform interlocks and process control logic associated with the Plant Process Control System. The Programmable Controllers provided under this Section shall be integrated into the overall (new and existing) Instrumentation and Control System for the Plant along with control panels and/or other new or existing PLC based hardware and software provided by other subcontractors or equipment manufacturer's.

B. All programmable controllers provided will interface and be fully integrated to the overall plant monitoring and control system

C. When designing a programmable controller (PLC) based Control Systems, the Supplier shall employ modern design concepts such as modular system design, multiple operational modes,

internal diagnostics, data collection, and peer and supervisory level connectivity. Modular design shall be implemented to facilitate incremental system expansion, graceful system failure, and software maintainability. Multiple operational modes shall be provided as noted on the Contract Drawings and Specifications (See Control Logic Descriptions in Contract Specification 13150) to allow for fully automatic, manual, or semiautomatic modes of operation in order to increase the maintainability and productivity of the system. Current and future needs for system coordination and higher level data collection and process supervision shall be accommodated by selection of products and features which support a high degree of connectivity.

D. Where programmable controllers are provided for small, low I/O Density (less than 100 I/O) applications like remote pump stations (usually associated with Telemetry Systems) or standard vendor packaged systems; fixed (non-modular) I/O style (Similar to Modicon Micro/Compact or A/B Micrologic or Siemens S3) programmable controllers can be utilized as dictated by Standard Industry Practices (allowable exception to requirement for Modular I/O type Programmable Controllers).

E. Transient Surge and Lightning protection shall be provided to protect all programmable controller hardware from induced voltages and power surges propagating along the discrete or analog signal I/O lines and/or power supply lines or digital communication connection to the Control system and/or Telemetry system. The protection systems shall be such that the surge protective device shall not interfere with normal operation, but shall lower the induced voltage level or transient surge level to be less than the instrument's (or control device's) surge withstanding level, and shall be maintenance free and self-restoring. Transient Surge and Lighting protection shall be provided in accordance with Contract Specification 13270 "Surge and Lighting Protection".

F. The scope of the Programmable Controller based control system will be as depicted on the Contract Drawings including the P&IDs with the approximate PLC I/O requirements as listed in Contract Specification 13120 "PLC I/O List". The party responsible for the design and configuration of the programmable controller based process control system shall be responsible for all programming, labor, and ancillary equipment and services required to achieve a fully integrated and operational system. This Subcontractor shall configure the control system for proper operation with related equipment and materials furnished by suppliers called out under other sections of these Specifications and with related existing equipment that includes existing and vendor furnished hardware and control system components. The Subcontractor shall design and configure the resulting process control system to guarantee full functionally and future expansion capability of the final process control system and to certify the proper installation and operation of all supplied equipment as well as integration with all existing and/or vendor furnished instrumentation and controls.

G. In additional to real world communication as shown on the Contract Specification 13120 "PLC I/O List", the PLC design may include the implementation of Virtual I/O Communication between the project's Control System and various non-Division 13 control systems that may contain other electronic controls like programmable controllers, embedded microprocessor based controllers, or vendor specific proprietary control systems. Required Virtual I/O Communication Links shall be shown on the project's Process and Instrumentation Diagrams (P&ID) and/or described in the project's control logic description specification 13150. Contractor is required to investigate all Virtual I/O Links and provide sufficient hardware, software, and configuration services to fully implement the required virtual communication so as to complete the functionality of the project's control system and to implement the intent of the additional functionality for virtual communication both in terms of monitoring and control that the Owner requires to properly operate his facility as described in the Contract Documents. Contractor is

fully responsible to recommend those Virtual I/O points that he feels provides for a fully functional and complete control system. Scope of work may include interfacing with the Engineer and/or Owner to insure that the Contractor proposed list of virtual I/O points is sufficient to provide the functionality required in the Contract documents.

H. All the Work in this Section shall be the sole responsibility of the designer of the programmable controller based process control system. Components and enclosures may be provided by other suppliers and/or manufacturers, but the integration, coordination, packaging, wiring and testing of these components and the production of the final product shall conform to this specification and shall be the sole responsibility of the programmable controller based process control system designer.

I. Design, furnish, fabricate, configure/program, test, and make ready for operation the programmable controller hardware and software required to integrate with instrumentation and control system design as required by the Contract Specifications including Contract Specification 13000 "Instrumentation and Controls – General Provisions" and as shown on the Contract Drawings.

J. Unless otherwise specified on the Contract Drawings, all control panels and I/O cabinets shall be of the fully enclosed type suitable for the mounting of the instrumentation and control devices as listed in the Contract Specifications and as shown on the Contract drawings.

K. All control panel and I/O cabinets shall be fully lockable with a lock installed in the door handle or by padlocking using a hasp and staple for padlocking. Locks for each control panel or I/O cabinet provided under this Contract shall be keyed alike.

L. For additional requirements associated with Control Panels and/or I/O Cabinets to be furnished with the Programmable Control System see Contract Specification 13200 "Control Panels".

2.02 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with contract requirements, manufacturers offering Products that may be incorporated in the Work include, but are not limited to, the following:

1. Allen Bradley (A/B) Programmable Controllers:
   a. Micro Logix (Mini-Fixed I/O base with Built-in Processor).
   b. SLC-500 (Medium Size Modular I/O System with a family of PLC Processors- SLC-5/4 Processors preferred for DH+ Communication Applications and SLC-5/5 Processors preferred for Ethernet Communication Applications).
   c. PREFERED - ControlLogix (Large Size Modular I/O System with a family of PLC Processors)

2.03 DESIGN OF PROGRAMMABLE CONTROLLER BASED CONTROL SYSTEMS

A. General Requirements

1. The Programmable Controller Supplier shall design, fabricate, and deliver a complete PLC system with hardware and software including the following:
   a. CPUs (Central Processing Units) – PLC processors (including math coprocessors where required).

b. Communication Interfaces or Processors.
c. "Real World" I/O systems including I/O Scanners, I/O Cards, and I/O Racks.
d. Power Supplies for Processors and I/O Systems.
e. Outside World Interface Hardware and Software.
f. Special Interconnecting Cables.
g. Miscellaneous components and signal conditioners.
h. Mounting Hardware.
i. Enclosures and I/O termination Cabinets.
j. Local Operator Interfaces, where required.
k. Programming and Online Diagnostic Software
l. Portable Programming Computers complete with PLC Programming and Online Diagnostic Software (and Local OIT/HMI programming and diagnostic software where such hardwire is supplied as part of the project), where specified.

2. The Programmable Controller Supplier shall offer the following additional services:
   a. Factory inspection and testing (to be witnessed by Engineer and/or Owner at their discretion).
   b. Installation supervision.
   c. On site testing and startup
   d. Operator and maintenance training

B. Design Criteria

1. The PLC Control System shall be designed for at least 99.9% availability through selection of reliable components, conservatively applied in accordance with the manufacture's specifications; through serviceable equipment arrangement and distribution of control functions and I/O points; utilizing detailed system diagnostics; and through quality of workmanship in assembly and installation. Complicated and costly redundant or fault tolerant configurations shall be employed only with the Engineer's or Owner's written approval.

2. The PLC Control System shall be inherently designed for reliability by distribution of process control functions across multiple PLC Processors and I/O Cards. Care shall be taken in implementing the PLC Control System design such that single component failures should not disable the entire PLC Control System. Consideration should be given to division of control logic according to process systems and/or equipment packages. To minimize process interruptions due to PLC failures, where redundant process equipment exists, each piece of redundant equipment shall be controlled by I/O points on separate I/O cards (to the maximum extent possible).

3. The PLC Control System as commissioned shall provide generous room for system expansion and optimization. No more than 60 percent of the available PLC system memory shall be used. Modular I/O racks shall be sized for 20 percent unassigned card slots. I/O terminal strips shall be sized to provide 30 percent unused terminals, including fused terminals. At least 20 percent spare I/O points shall be supplied, fully installed and wired to field terminal strips.

4. All PLC Control Systems shall be design and implemented in accordance with the PLC manufacturer's recommendations. This shall include recommended techniques for voltage and power separation, grounding, and surge and noise suppression.

5. All Emergency Stop and other personnel safety (and critical equipment, where noted) interlocks should hardwired utilizing conventional relays. Except for these safety interlocks, all other process interlocks should be implemented in software using the supplied programmable controllers.

6. Separate PLC inputs and outputs shall be used for connection of each device to the PLC Control System. The use of parallel or series wired circuit applications will require written approval from the Engineer's or Owner's. An exception to this requirement would be the application of pilot lights for indicating the status of an input device, which need not be connected to an output module.

7. Field device terminations and wiring will be routed to the field terminal strips located in the associated Control Panel or I/O Cabinet where the PLC I/O points will be located. Different voltage levels will be segregated and clearly labeled to prevent personnel injury and damage to instrumentation and controls.

8. The scan time of the PLC program shall be sufficiently fast to support the normal and emergency operation of the attached equipment. Under no circumstances shall the overall scan time exceed 300 millisecond.

9. Except for safety interlocks, all electrically operated equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored. Upon loss of electrical power, all PLC outputs shall "de-energize" due to loss of electrical power but shall resume their previous states when the power is restored. "Failed to Start" and "Failed in Operation" alarming shall be provided to warn the operator of the loss of power conditions that may be due to Utility power failures, wiring faults, breaker or fuse trips, or equipment malfunction.

10. The PLC System shall be designed for ease of maintenance. All configuration dipswitches and jumpers on the PLC Processors, I/O Racks, I/O Modules, and Interface modules shall be set appropriately by the PLC Supplier. The PLC I/O System shall be configured to group like I/O modules together with appropriately labeling and "keying"to minimize the potential for improper placement of replacement modules.

11. PLC Processors and I/O Modules shall be provided with Conformal Coatings when it is expected that they will be located in highly corrosive or high humidity environments.

C. PLC Hardware Requirements

1. Central Processing Unit – PLC Processor
   a. The central processing unit shall have sufficient instructions to perform all data manipulation, arithmetic functions (+, -, X, /, =), function block operations, and binary logic required or reasonable anticipated for each application. The ability to perform PID type Control shall be supplied where continuous analog process control functions will be required or may be utilized in the future. Where extensive floating point mathematics will or could be utilized, a built-in or separate Math Coprocessor shall be supplied.
   b. The central processing unit shall support Relay Ladder Logic. The use of Relay Ladder Logic to implement interlock and process control in each programmable controller is recommended. Other languages (for example, BASIC, Statement Lists, Function Blocks, Sequential Function Charts, or Boolean) may be used only with the Engineer's or Owner's written approval.

c. The basic functionally (PLC programming instructions) of each central processor shall be implemented utilizing permanent non-volatile memory (firmware). The preference is for each PLC processor would be to utilize flash memory so that PROM or EPROM memory modules will not have to be "swapped out" to upgrade the functionality of each processor. The supplier shall state each PLC processors' firmware upgrade method in his submittals.

d. The User/Application program for each PLC processor shall be stored in low power CMOS type RAM memory, EEPROM, or flash memory modules as appropriate for each application and the type of PLC processor chosen. Sufficient User/Application program memory shall be supplied with each PLC Processor in accordance with the Contract Requirements and with the PLC Design Criteria as listed in Paragraph 2.03B above. All PLC programs shall be retained during power outages through the use of battery backed up RAM or EEPROM (or flash memory modules). Wherever batteries are used, lithium batteries shall be utilized and the PLC processor shall be programmed for low battery alarming. The supplier shall state list the amount and type of memory supplied with each PLC processor. The anticipated memory use in each application (PLC Program memory requirement is usually provided as feature of the PLC programming package) shall be provided as integral part of his PLC submittals.

e. The PLC processor shall be furnished with the ability to communicate with the following external devices:

   i) Personal Computer – for programming/troubleshooting

   ii) Local Operator Interface, if required

   iii) Remote I/O Modules

   iv) Networking connection to other PLC Processors or Plant Control System utilizing the vendor's standard communication protocol or ModBus RTU protocol as agreed with Engineer or Owner.

2. PLC Power Supplies

   a. Supplier shall furnish all power supplies and line filtering equipment required for continuous operation of the PLC system. AC power may be feed from a central or distributed (local to each PLC or Control Panel) Uninterruptible Power Supply (UPS) System as determined by the Contract drawings and as defined in Section 2.03D below.

   b. Each individual power supply and separately powered component of the PLC system shall be capable of operating from an external AC power source. Typically, this will be a 120VAC Power source from the plant electrical system. Consult with the Engineer and Owner, if alternate DC or AC power sources can be utilized. Units that receive a 120VAC power source, shall be capable of operating under the following conditions without degrading performance of any component of the PLC system:

      v) Input Voltage of 120 VAC +/- 10 percent

      vi) Input Frequency of 60 Hz +/- 2 Hertz

      vii) Ambient Temperature: See Site Operating Conditions as stated in Contract Specification 13000 Section "Project/Site Requirements".

3. I/O Racks

   a. I/O Modules associated with each PLC processor can be mounted local or remotely to the PLC processor depending on I/O density and individual application. Smaller capacity PLC processors are often packaged together with a small amount of I/O in a compact mounting base. For applications where more than several dozen I/O points are to be located at a particular location, the preference will be for I/O points to be

implemented utilizing plug-in I/O modules in a modular of I/O Cabinet/Rack. This approach will allow for greater expansion and flexibility in the quantity and type of I/O available now and at the future at each I/O location.

b. In addition to the current I/O requirements, PLC I/O racks shall be chosen to allow for the required percentage of future I/O expansion in terms of I/O points and I/O Module spare slots (to allow for other types of I/O modules as well as addition of additional existing I/O module types). Multiple I/O racks may be needed at each location to accommodate the current and future I/O requirements. I/O racks shall be distributed to minimize cable runs and accordingly to the distribution of process control functions by process systems.

c. All PLC I/O points whether provided as plug-in modules or in Fixed I/O mounting bases shall be supplied with all installation and maintenance, mounting hardware, interconnect cabling, and associated remote I/O and "Outside World" interfaces. Modular I/O Racks shall be mounted and wired such that individual I/O modules can be removed without disconnection of field or interconnection wiring.

d. All dipswitches or jumpers shall be configured and set for proper operation on all PLC Hardware including PLC Processors, I/O Racks, I/O Modules, and External Interfaces. Modular I/O Racks shall be mounted and wired such that individual I/O modules can be removed without disconnection of field or interconnection wiring.

4. I/O Modules
   a. Digital (Discrete) Inputs
      i) The discrete input modules shall be able to accept inputs from field devices such as limit switches and pushbuttons. Each discrete input point shall be optically isolated (provide at least 1,000V isolation) from the internal electronics of the I/O card. The energized state of an each PLC input shall be indicated with light emitting diodes.
      ii) The discrete input modules shall be able to detect and eliminate relay chattering or contact bouncing.
      iii) High density digital inputs utilizing 16 points per card shall be used whenever a large number of devices of a given signal level are required. Higher density modules utilizing 32 points per module shall not be used without the Engineer's or Owner's approval.
   b. Digital (Discrete) Outputs
      i) The discrete output modules shall be able to activate solenoids, motor starters (up to size 3 preferably), and coils with loading of up to 2 amps per output point. Each discrete output point shall be optically isolated (provide at least 1,000V isolation) from the output card electronics. The individual outputs shall have light emitting diodes to indicate when the output is energized.
      ii) The current rating of most PLC Outputs usually prevents the interfacing to motor starter coils above NEMA Size 3. When interfacing to larger inductive loads, the PLC supplier shall be responsible to coordinate the use of Interposing relays to be located at the PLC I/O Card (in this case to be supplied by the PLC Supplier) or to located at the external load (provided by others). In disputes over scope of supply, the PLC supplier shall provide the appropriate relays or other interfacing hardware to implement the control of the external load(s).
      iii) Internal suppression shall be provided to prevent false triggering. External surge suppressors shall be provided for large inductive loads. External loading characteristics including minimum loads for Triacs and maximum inductive loads

shall be stated. These loading characteristics shall be observed in the selection and interfacing to contractor supplied instrumentation and controls.

iv) When digital outputs that contain TRIACs are utilized, care shall be taken when interfacing with high input impedance loads like PLC Inputs or VFD Control Circuits. The high leakage current of some TRIAC's outputs may prevent the device from detecting that the PLC output has turned "OFF". In such cases, the PLC supplier shall be responsible to add interposing relays or change the type of PLC Output card to allow proper operation of the controlled device.

v) High density digital outputs utilizing 16 points per card shall be used whenever a large number of devices of a given signal level are required. Higher density modules utilizing 32 points per module shall not be used without the Engineer's or Owner's approval.

c. Analog Inputs

i) The analog input modules shall receive analog signals (low voltage or low current) from field instrumentation (transmitters, transducers, etc). The received analog signals shall be converted to a digital signal inside the Analog Input Module. The analog to digital conversion shall be implemented by A/D converters that are optically isolated from the field inputs (provide at least 1,000V isolation).

ii) Analog Inputs shall be continuous converted to a digital value with detection of under-range and over-range signals. Preferably, each analog input point shall be connected to a separate A/D converter (not more than 8 analog inputs should be connected to a single A/D converter). The A/D conversion resolution shall be at least 12 bits.

iii) Use of single ended input cards is prohibited – all analog inputs shall be individually isolated relative to each other point on the same I/O card or PLC Cabinet. When interfacing to non-isolated devices, the PLC supplier shall be responsible to provide signal isolators or isolated input modules (differential mode inputs) to prevent ground loops and to insure that accurate and repeatable signals are received from the transmitting device. Analog inputs associated with the use of surge protection or intrinsic safety barriers may require isolated (differential mode) input modules. Careful consideration shall be taken before mixing 2 wire and 4 wire transmitters on the same I/O Card or series'ing 2 wire and 4 wire devices together as a common analog input.

iv) Whenever appropriate for the given application, analog signals shall be standardized on 4-20 ma DC. However, for a large number of thermocouple and RTD inputs (sufficient to justify the non-standard cable type required), a dedicated purpose temperature input module is preferred over the use of transmitters for the sole purpose of signal conversion to 4-20 ma DC. Thermocouple inputs shall have cold junction compensation and RTD inputs shall ambient temperature compensation and lead wire length compensation. Temperature modules shall automatically convert the measurement to temperature measurement in terms of degrees Celsius or Fahrenheit as selected.

v) When interfacing to smart transmitters (especially those that utilize carrier wave signals like HART Protocol), the PLC Supplier shall choose I/O Modules that are compatible with the transmitted signal and/or shall utilize signal conditioning devices to prevent interference to the I/O module's input circuitry.

vi) Multi-point analog input modules utilizing 8 points per card shall be used whenever a large number of devices of a given signal level are required. Higher

density modules utilizing 16 points per module shall not be used without the Engineer's or Owner's approval.

d. Analog Outputs

i) The analog output modules shall send analog signals (low voltage or low current) to field instrumentation (panel meters, metering pumps, VFDs, etc). Discrete output signals inside the Analog Output Module shall be converted to analog output signals. The Digital to Analog conversion shall be implemented by D/A converters that are optically isolated from the field inputs (provide at least 1,000V isolation).

ii) All Analog Output signals shall be 2 wire type isolated regulated outputs. Preferably, each analog output point shall be connected to a separate D/A converter (not more than 8 analog outputs should be connected to a single D/A converter). The D/A conversion resolution shall be at least 12 bits.

iii) Whenever appropriate for the given application, analog signals shall be standardized on 4-20 ma DC. All analog outputs shall be PLC powered (2 wire) and individual isolated. Preference is for voltage outputs to be generated via adding a voltage dropping resistor to current type analog output signals. Current regulated analog outputs shall be capable of driving at least at least a 600 ohm load utilizing a nominal 24V volt power supply. Voltage regulated analog outputs shall be capable of driving at least a mega ohm load.

iv) When interfacing to smart devices (especially those that utilize carrier wave signals like HART Protocol), the PLC Supplier shall choose I/O Modules that are compatible with the smart device and/or shall utilize signal conditioning devices to prevent interference to the I/O module's output circuitry. Loop Isolators may be required when outputting to more than one smart device or to a smart device in series with a non-smart device.

v) Multi-point analog output modules utilizing 8 points per card shall be used whenever a large number of analog outputs are required. Higher density modules utilizing 16 points per module shall not be used without the Engineer's or Owner's approval.

e. Frequency (High Speed Counter) Inputs

i) Where required provide special high speed counter modules to accept frequency type inputs from devices such as flow meters, motion detectors, and other pulse generating equipment. Each input shall be locally counted integral to the I/O module such that current setting of the PLC Scan time will not cause any inaccuracy in measuring the pulse count. Each input shall be selectable for local or external power and shall have the ability to accept a range of voltage inputs. The energized state of an input shall be indicated with light emitting diodes. Internal protection shall be provided to protect against external voltage transients.

ii) Multi-point frequency input modules utilizing 4 points per card shall be used whenever a large number of frequency measurements are required. Higher density cards utilizing 16 points per module shall not be used without the Engineer's or Owner's approval.

f. Serial Data Ports

i) The PLC System shall have the ability to communication to programming terminals and/or other communication links utilizing Serial Data Ports where required for each application (see Contract Drawings). Serial Data Ports shall be supplied as part of the PLC Processor or as separate modules as required.

ii) The preferred interface for Serial Data Ports shall be EIA-422 (or EIA-485). However, whenever interconnecting devices support only EIA-232-C, the PLC Supplier shall take into account the cabling distances between the Serial Port at the PLC and the connection to any intelligent field device. For any applications requiring installed cable lengths in excess of 50 feet, the PLC Supplier shall furnish and install appropriate line driver modems.

iii) The PLC Supplier shall configure all serial data ports and furnish all communication drivers or protocol converters to reliably and efficiently communicate to specified systems as required for each application.

5. Data Highway Links
   a. The PLC System shall be furnished with the ability to communicate to other PLC Processors or to the overall (new and existing) Instrumentation and Control System for the Plant (Telemetry, SCADA or DCS monitoring and control system(s)).
   b. The PLC Supplier shall provide serial and/or network interfaces to facilitate the required communication in accordance with the network configuration requirements and data transfer rates required for each application. Provide all hardware components, standard communication drivers, and any application software required to satisfy these functional requirements.

6. Portable Programming Terminal – as Required
   a. Where shown on the Contract Drawings, the PLC Supplier shall supply a Portable Programming Computer (laptop) complete with PLC Programming (Offline) and Online Diagnostic Software (and Local HMI programming and diagnostic software where supplied).
   b. The portable PLC programming terminal shall be an IBM compatible personal computer (laptop) with the appropriate hardware interface module(s) to permit program downloading to, and program uploading from each type of PLC Processors supplied. The terminal shall provide a means of monitoring program execution and overall system status. Terminal interactions such as I/O forcing, data manipulation, and system initiation shall be supported by the programming terminal. Each terminal shall be furnished with the necessary software for on-line and off-line program development and off-line program documentation. Each programming terminal shall be provided with sufficient storage capacity to act as a programming terminal for the programmable controller as well as for the MMI/OIT, if supplied.
   c. Minimum Specifications for the portable PLC programming terminal:
      i) New Laptop Computer containing at least 2 Gigahertz CPU with at least one year manufacturer's warranty
      ii) Operating System: Microsoft Windows 7 Professional including the latest service packs
      iii) RAM Memory: at least 4 Gigabytes
      iv) DVD Drive
      v) Hard Drive: at least 500 Megabytes
      vi) 56K Modem
      vii) At least one Communication Port either as a RS-232 or USB port for external communications
      viii) Parallel or USB Port for Printer communication

7. Operator Interface Terminals (OIT) – as Required
   a. Where shown on the Contract Drawings, the PLC Supplier shall supply local Operator Interface Terminals (OIT) at each local Control Panel for each of maintenance and troubleshooting.
   b. The Operator Interface Terminals shall display graphical representations or schematics of the processes and equipment. Data shall be presented in the conventional overview, group, and point hierarchical display scheme. Formats shall be the Supplier's standard unless otherwise specified. A chronological alarm summary that displays the most recent points in alarm shall also be provided
   c. Each Operator Interface Terminal shall be equipped with an alarm annunciation horn that sounds when a new alarm is detected. A minimum of seven (7) dedicated function buttons at each Operator Workstation shall give the operator a single-button command to perform certain predetermined functions. Optionally, this may be accomplished by way of monitor touch screen targets or predefined callup keys. Under password security control, the operator shall also be able to adjust tuning constants and control parameters of modulating control loops.
   d. Operator Workstation shall utilize at least an INTEL 80486DX2-66 MHz or Pentium Central Processor Unit (CPU)-based IBM Personal Computer (PC) or 100% compatible alternative. The CPU shall operate at a clock rate of at least 66 MHz. A math co-processor, parallel communications port, and at least one serial communications port shall be provided.
   e. Random Access Memory (RAM) of at least 8 Mbytes and mass storage capacity of at least 512 Megabytes are required; however, the system provided shall be based upon the minimum requirements of the application software with appropriate allowance for future expansion. The video display driver shall provide 256 colors at 640 x 480 resolution and 512 Kbyte Video RAM.
   f. Removable mass storage shall be provided by an internal CD or DVD drive. A network interface compatible with IEEE 802.3 Ethernet CSMA/CD protocol will be provided if specified on the Contract Drawings. Physical connection via 10Base2 "thin wire" coaxial cable is preferred.
   g. Real-time, multi-tasking Operating System (OS) such as VMS, UNIX, MS Windows XP, or MS WINDOWS 7 is required with WINDOWS 7 being preferred.
   h. A LCD type color monitor of at least 12" inches diagonal is required. A keyboard or sealed touch screen incorporating environmental protection for switch contacts and active electronic components is required. A cursor control device or touch screen shall be provided; a track ball is preferred over a mouse and touch screen preferred over trackball. Each Operator Workstation shall be integrated into a NEMA 3R/4-rated industrial cabinet with work space area and good ergonomical design. All operator consoles should include at least one PLC I/O rack to minimize the number of control panels.
   i. For each type of OIT hardware provided for the project, the supplier shall include a fully licensed and fully functional copy of the programming and diagnostic software (capable of offline and online operation) for said furnished device. This software will be installed on the programming laptop furnished with the project for PLC programming and troubleshooting. As approved copies of all configuration files relative to the configuration of the furnished OIT's and/or HMI interface terminals shall also be stored on the hardwire of the furnished PLC Programming laptop and made available to the Owner for his use prior to the start of Substantial Completion and if possible during the Continuous Operations Testing phase of the project proceeding

Substantial Competition. In all other aspects this OIT/HMI programming and diagnostic software and associated configuration files shall comply with the requirements of the PLC Software Development section below as far as scope of supply and submittal and approval of what is furnished by this requirement.

D. Power and Grounding Requirements

1. External power connections (AC or DC) to PLC Equipment shall be installed in accordance with the manufacturer requirements and shall have surge and lightning protection in accordance with Contract Specification 13270 "Surge and Lighting Protection".

2. AC Power feeds to PLC Equipment and associated instrumentation shall be supplied from Isolation Transformers that are properly grounded in accordance with the National Electrical Code and the PLC Manufacturer's recommendations (typically this would required a Grounded Neutral on the transformer secondary side that is connected thru a dedicated grounding conductor to each connected AC power load).

3. For those projects where the voltage tolerance of the AC power feed exceeds the requirements of the connected PLC Equipment, a constant voltage transformer of sufficient size shall supply power to each PLC processor and remote I/O power supply. Additionally, this transformer shall be sized to accommodate all powered Digital inputs to the PLC System.

4. To minimize the impact of momentary power interruptions (loss of operating state of process equipment, need to reload PLC programs, loss of diagnostic information, etc.), the AC Power feed to the PLC System shall be feed from a central or distributed (local to each PLC or Control Panel) Uninterruptible Power Supply (UPS) System. Failure of the UPS System shall be alarmed locally at each unit with remote status via input to the PLC System.

5. When Control Panels and/or I/O Cabinets are provided, a dedicated circuit breaker protected outlet connected to the PLC power source shall be provided for use by a portable PLC programming terminal. Conventional convenience outlets and panel lighting shall be powered from a separate miscellaneous power panel circuit.

6. Since solid state circuits (especially for PLC processors and Analog I/O points) associated with Programmable Controllers utilize low voltage signals, it is critical that the PLC System be properly grounded to a low impedance earth ground in accordance with National Electrical Code and the PLC Manufacturer's recommendations. The Supplier shall coordinate the grounding of the PLC System with the Electrical Contractor and submit his Power and Grounding design to the Engineer for approval prior to Installation.

7. PLC Outputs connected to motor starters or VFD's should be powered externally from the control power associated the individual starter or drive. This will require Isolated Output cards for such motor control. Status Contacts from the motor starter or VFD should be powered via the normal power distribution at the PLC I/O Card.

8. AC Power distribution to I/O Cards shall be distributed thru dedicated circuit breakers. Power distribution shall be designed to minimize the potential for the loss of a power feeder (tripping circuit breaker or melting feeder cable or distribution wiring) when one or more connected PLC I/O Points are shorted. An example of this design would be that a single power feeder (20 Amp Circuit Breaker) should not feed more than 16 PLC Outputs (Max Output of 2 Amps each). Similarly, a single power feeder should not feed more than 32 PLC Inputs.

9. Additionally, AC Power Distribution should be fused protected to limit the loss of PLC information due to wiring shorts. An example of this requirement would be to provide power distribution fuses (via fused terminal blocks with blown fuse indication) for every individual discrete PLC outputs and every four (4) discrete PLC inputs. Additionally, all 24V DC distribution to individual analog I/O points should be individually fused (with blown fuse indication).

10. Power distribution wiring should be "doubly feed" such that the loss of one jumper wire or the removal of one terminal block will not affect the other I/O points being feed. This applies to both the 120 VAC Hot and Neutral jumper'ing for AC Power distribution and for +24V DC and Neutral (-24V DC) for DC Power Distribution.

E. PLC Software Development

1. PLC software documentation shall be developed on an approved, commercially available, personal computer based PLC program development system. Except for standardized vendor equipment packages, all custom PLC Programming shall attempt to utilize the program development package currently preferred by the Owner. Should there be no Owner preference; the supplier shall confirm his choice of PLC program development package with the Engineer. Should the package chosen be non-standard for the Owner, the supplier shall include furnish one fully functional and licensed copy of the package with his PLC equipment. In all cases when a portable programming terminal is furnished with the PLC equipment, a copy of the PLC program development software shall be loaded on and supplied with the terminal. This software package shall be fully functional and capable of online and offline programming of the supplied PLC Processors. All instruction manuals shall be included and the program shall be registered to the Owner with license/registration fees paid for support and program updates thru the one-year warranty period after substantial completion.

2. PLC Software submittals shall consist of 2 hard copies of fully commented source code (with detailed Rung and Element comments). After substantial completion and approval of the PLC Software submittal, the PLC supplier shall furnish two hard copies of the fully commented source code and three sets of all source code and executable code in machine-readable format (CD-ROMs). The PLC Supplier shall retain a record copy of all as commissioned software media for a period of at least 1 year after substantial completion.

3. The PLC program when loaded on each PLC processors shall be password protected to prevent modification of the program by unauthorized personnel. If possible, multiple levels of passwords shall be implemented. Maintenance functions like forcing contacts and changing timer values shall be protected by a different password than full program change access.

4. Upon substantial completion in agreement with the Owner, the PLC Supplier shall reset the final password(s) for all PLC program furnished to those preferred by the Owner.

5. The PLC Program shall include monitoring of PLC diagnostic information (PLC memory errors, Low Battery Alarm, PLC Faults, Communication errors). PLC Diagnostic errors shall be time stamped and logged to facilitate troubleshooting of non-catastrophic PLC failures.

6. PLC serial or network interfaces to external monitoring and control systems – Telemetry, SCADA, DCS, etc shall be coordinated with the respective supplier. Additional programming to detect external communication failures and/or loss of data shall be implemented by the PLC Supplier. This may include adding Watchdog Timers to be reset

by the external system(s) or the sending of periodic "heart-beat" type communications to external system(s). Communication failures shall be logged and alarmed. Additional control actions may be required as a result of loss of communication.

2.04 MAINTENANCE REQUIREMENTS

A. Maintenance Requirements of all programmable controller hardware and software shall be in full conformance with the Contract Specifications and with Division 13 Contract Specification 13000 Section "Maintenance Requirements" and as specified herein.

B. Maintenance Requirements of all associated Control Panels and/or I/O Cabinets shall be in full conformance with the Contract Specifications and with Division 13 Contract Specification 13200 Section "Maintenance Requirements".

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. PLC Equipment supplied under this section shall be installed per the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions" and Division 13 Contract Specification 13270 – "Surge and Lightning Protection".

B. All PLC Equipment and associated instrumentation and controls shall be installed in accordance with the manufacturer's instructions. The locations of PLC processors, control panels, and I/O Cabinets shown on the Drawings are approximate only. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of instrumentation and controls work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

C. PLC Equipment and associated instrumentation and controls furnished under this specification shall be factory tested prior to shipment. Field installation shall consist only of setting the equipment in place and making necessary electrical and pneumatic external connections.

D. The supplier shall be responsible for checking out grounding and other safe operation concerns for all supplied control panels, PLC hardware, and other sensitive electrical or electronic control system equipment prior to energization of temporary or permanent power supplies.

E. All furnished equipment shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and I/O cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged units or systems shall remain on site and returned to the manufacturer after the replacement units or systems have been delivered to the site. Under no circumstances will instrumentation or controls equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied, and all costs associated with replacement shall be borne by the Contractor.

F. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer. The entire damaged enclosure panel or section shall be repainted per the contract field painting specifications, at no additional cost to the Owner.

3.02 INSPECTION AND TESTING

A. PLC Equipment supplied under this section shall be inspected and tested per the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Cotnrols – General Provisions" and Division 13 Contract Specification 13270 "Surge and Lightning Protection".

B. Test all instrumentation and control system components furnished under this Specification and repair or replace all defective equipment or work. Make all necessary adjustments and instruct the Owner's personnel in the proper operation of the instrumentation and controls provided.

C. All PLC Equipment supplied shall have a 100 % point to point wiring checkout prior to being shipped from the supplier or panel fabricator. All PLC I/O shall be "real world" simulated from I/O card to/from the panel mounted devices or field terminal blocks. Virtual I/O communication links shall be tested and verified for fully functionality per approved PLC or DCS Software Submittals. All Virtual I/O points shall be tested or simulated to demonstrate functionality and demonstration failure diagnostic functions. Engineer and/or Owner shall have to opportunity to witness all testing.

D. Test grounding and verify any other safe operation concerns associated with all supplied control panels, PLC hardware, intrinsic safety equipment, and other sensitive electrical or electronic control system equipment prior to energization. Supplier shall certify that the grounding and installation is in conformance with the manufacturer's warranty requirements prior to providing temporary or permanent power to any supplied equipment. Submit copies of certified installation and grounding test reports.

E. Prior to plant operation, test all instrumentation, controls, and interlocks to verify that the instrumentation and control systems will function properly and as indicated by the Contract Drawings and as noted in the approved shop drawings. Verify wiring installation against loop sheets and interconnect wiring Verify software I/O addressing and configuration against detailed software engineering documents. Virtual I/O communication links shall be tested and verified for fully functionality per approved PLC Software Submittals.

F. All testing shall be scheduled and coordinated by the Contractor. Notify the Engineer and Owner at least two (2) weeks in advance of conducting tests. The Contractor or Subcontractors under this Division shall have qualified personnel present during all testing.

G. All test data and procedures followed during testing shall be logged, and certified copies of the logs shall be provided to the Engineer and Owner.

3.03 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

3.04 TRAINING

A. Programmable Controller Equipment and associated instrumentation and controls supplied under this section shall be incorporated in the overall training plan as required by the Contract Specifications including Division 13 Contract Specification 13000 "Instrumentation and Controls – General Provisions".

END OF SECTION 13400

SECTION 13500
DISTRIBUTED CONTROL SYSTEM (DCS)

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, material, and software required to furnish, install, test, calibrate, place in operation, and document an extension to the existing Foxboro Distributed Control System (DCS) at RM Clayton WRC to serve as a remote communication and monitoring link to the new Plant Control System at the North Fork Peachtree Creek project site and configured by the DCS system integrator as required by the Contract Drawings and in this Section. This virtual communication link shall be complete and fully function and shall display all process information present at the remote site with limited remote control functionality. New Foxboro Graphics shall be added to the existing Foxboro DCS System at the RM Clayton WRC for the Liddell Drive Equalization Facility. Graphics shall be similar to other COA Deep Well Pump Stations and shall follow all COA graphics standards. Note that due to the project design there will be two separate PLC control systems for the project – one housed in a Local Control Panel in the Diversion Facility Electrical Building and a separate one housed in a Local Control Panel in the Equalization Facility Electrical Building.

B. Provide DCS training of the City's personnel at the DCS Supplier's facility and at the job site.

C. Update the existing City systems to the latest level of software consistent with the new system.

D. Provide a DCS maintenance contract.

E. Provide DCS guarantees and warranties.

F. The following DCS system integrators are pre-qualified to perform the work specified in Section 13500 without the need to provide Evidence of Experience:

1. Foxboro Company
   Patrick Young
   678-421-2325
   706-407-8038 (cell)
2. Feedforward, Inc.
   Craig Mercer
   770-426-4422
   cmercer@feedforward.com
3. Contractor-proposed DCS Systems Integrator shall be evaluated based on submittal of the following Evidence of Experience:
   a. Submit evidence of experience in performing three similar successful projects in the last five years with one project currently in progress or competed within the last two years.
   b. Submit project descriptions with contact names, addresses, and telephone numbers from the project Owner, General Contractor, and Principal Design Firm.
   c. Submit organization chart and resumes for proposed project personnel.
   d. Submit Training and Certification information. Completion of the following training courses or appropriate portions thereof or possession of the following certifications

included with the Systems Integrator's personnel experience requirements described above:

i) Project manager: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.

ii) Systems engineer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration, or completion of the relevant core courses in the Engineering Skills Training program.

iii) Programmer: Control System Engineer (CSE) registration, Professional Engineer (PE) registration.

iv) Field instrument technician: Certified Control Systems Technician (CCST) registration or completion of the relevant core courses in the Technical Skills Training program.

v) Certified training programs, as offered by ISA.

e. Submit financial data for Systems Integrator division when subsidiary to a parent corporation. Include two years of financial data.

i) Financial Statement.

ii) Balance Sheet.

iii) Dun & Bradstreet Report.

f. This submittal is due no later than two (2) weeks prior to bid date. Bidders will be advised of approval or rejection in writing no later than fourteen days prior to Bid Date. Rejected submittals may be supplemented with additional information and resubmitted no later than one (1) week prior to the Bid Date. Bidders making supplementary submittals will be advised of approval or rejection in writing no later than three (3) days prior to Bid Date.

4. Approval of a completed Evidence of Experience by the Engineer is dependent on his determination that the proposed system integrator has sufficient company experience, company expertise, and experienced qualified personnel in new and remodeling work of municipal instrumentation and control systems, has the ability to understand and perform the Work specified, has sufficient financial resources and has not had a detrimental impact to the scope on prior construction projects.

G. Related Work Specified Elsewhere:

1. Division 1 General Requirements
2. Section 13000 Instrumentation and Controls - General Requirements

H. Liddel Drive Equalization Facility Plant Control System configuration as described in the Specification Section 13150 Instrumentation and Controls - Control Logics Descriptions and shown on the P&IDs.

1.02 TESTING

A. Factory Testing:

1. The complete DCS including all hardware, software, and interconnections shall be staged and tested at the factory prior to shipment. The Factory Test shall verify that the configured DCS conforms to requirements. The test shall conform to Section 8, Recommended Tests for Interacting Systems, established by the Instrument Society of America under Standard

RP 55.1, unless otherwise required. The test shall simulate all operating conditions including steady-state, start-up, shutdown, and power failure. Testing shall not relieve the Contractor or the DCS supplier from requirements herein.

2. Preparation: The test may be witnessed by the Engineer. Provide written notice of start date twenty (20) days prior to beginning the test. Submit procedures thirty (30) days prior to beginning the test. Procedures shall include a schedule of each step, the expected results, and the method for discrepancy resolution.

3. Configuration Audit: Audit the hardware and software provided. Verify conformance of the staged hardware to the approved configuration. Verify cabling, module configuration (including spare slots and connectors), spare components, expandability, physical appearance, and workmanship. Audit software by title, revision identification and date, and other identifying information. Verify availability of all necessary test equipment.

4. Human Interface: Verify the operation of each human interface device including hardcopy generators, monitors, touch screens, function panels, keyboards, mice, and trackballs. Verify displays including environment configurations, passwords, security, etc. Verify operator navigation within the overall display structure. Verify each display for layout, symbols, colors, etc.

5. Data Acquisition: Test the system database using module configuration data sheets as a guide. Verify analog inputs at three points rising and falling (0, 50, and 100 percent). Verify each alarm function. Verify scan rate, offset or gain, filtering, delta band, and engineering units. Toggle digital inputs to verify functions and scan rate.

6. Loop Functions: Verify the automatic and manual functions of each loop using I/O simulation. Verify interfaces to other systems using communication emulators. Test or simulate all virtual communications links to verify functionality and demonstration failure diagnostic functions.

7. Data Management Testing: Verify Application Processor and Historian data collection, retrieval, display, and reporting periodically during the test using manually entered data and real time data collected by simulation.

8. Failure Mode Testing: Test all failure modes including loss of primary power source, loss of communications (Fieldbus, Nodebus, or LAN), loss of primary fault tolerant processors, loss of system communications (Fieldbus, Nodebus, or LAN), and loss of primary hardcopy devices.

9. For redundant communication links, verify that no single point of communications failure results in loss of function. Disconnect the primary communication cable (Fieldbus, Nodebus, or LAN), and verify that the automatic switchover to the redundant link is transparent to operation with no degradation of data transfer. Verify proper operation after reconnecting the cable.

10. Shut down or physically remove fault tolerant devices and verify no degradation of operation.

11. Verify the transfer of functions among hardcopy devices upon device failure.

12. Diagnostics: Verify the network diagnostics provided using the System Management Display Handler (SMDH). Alarms generated during the previous phase shall be observed, investigated as to the cause, and acknowledged through SMDH displays. Review performance information statistics. Verify on-line diagnostics.

13. Documentation: Provide evidence that each step has been satisfactorily performed. Include itemized check lists for each step and a witness signature area. Indicate any unresolved concerns. Provide all hardcopy information generated during the test.

14. The DCS shall not be shipped until the Factory Test and associated documentation has been satisfactorily completed as determined by the Engineer. Factory Testing shall also conform to the Pre-operation Testing requirements of the General Conditions Specifications including Section 01650 Facility Startup.

15. The cost of travel, meals, and lodging for the City's personnel while witnessing the test shall be paid from the travel and subsistence allowance.

B. Operational Field Testing:

1. Check and approve the installation and connection of all DCS components prior to placing them into operation.

2. Repeat the following steps of the Factory Test:
   a. Configuration Audit.
   b. Human Interface.
   c. Failure Mode Testing.
   d. Diagnostics.

3. Assist with the Installed Tests and Inspections of Section 13000 - Instrumentation and Controls – General Provisions. Provide all test equipment necessary to perform the DCS testing.

C. Functional Field Testing:

1. Perform a complete system test to verify that all equipment and software is operating properly as a fully integrated on-line system. Verify that the intended monitoring and control functions are fully implemented and operational. Tune control loops as required.

2. Functional Field Testing shall also include all testing and documentation required for Functional Testing requirements of the General Conditions Specifications including Section 01650 Facility Startup.

3. The system guarantee and warranty period shall begin upon successful completion of the 30 days Acceptance testing as described in Spec Section 01650..

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions and Special Conditions Sections of the Contract Documents and with Contract Specification 13000. In addition, the following specific information shall be provided:

1. Preliminary loop drawings in general accordance with ISA S5.4. At the DCS end show FBM connections and as a minimum the I/O block definition. Make provisions to show all components and associated connections required including the following information:

2. Tag numbers of each item.

3. Functional name of each item.

4. Manufacturer's model or catalog number for each item.

5. Location of each item.
6. Loop wiring drawings for panels and field components provided under Section Instrument Panels
7. Prior to the Operational Field Testing, provide updated loop drawings with all information as required above.
8. Field signal input/output (I/O) list with each point individually listed and cross-referenced to the loop drawings. Include updated versions of all additional or revised I/O points for this contract.
9. Virtual PLC I/O lists for each interfaced stand-alone control systems. Submitted Virtual Communication information shall include a complete list of all PLC I/O points that are being communicated virtually to and from each furnished PLC and shall provide project and vendor specific information on the type of communication protocol being proposed, complete listing of all virtual I/O points available in each interfaced device, vendor specific internal addressing, and the recommended/required points being proposed to be communicated over each required Virtual Communication Link.
10. Legend and abbreviation list.
11. DCS interconnection drawings showing all equipment, equipment locations, interconnecting cables and connectors with lengths indicated, and communication links. For Virtual Communication Links provide details on the DCS Foreign Device gateways and associated connections to remote Division 13 Control Systems (Plant Control System at the Liddell Drive Equalization Facility provided under Division 13 Specifications including Specification 13400) and any new hardware required to interface to existing DCS data highways. If non-division 13 virtual communication links are required for the project – provide similar information for those links.Enclosure layout drawings including the following information:
    a. Front, side, and plan views.
    b. Dimensions.
    c. Nameplate legend including text, letter size, and colors to be used.
    d. Terminal block designations cross referenced to the I/O list.
12. Complete material and software list. Identify software components by title, functional description, revision identification and date, and other appropriate identifying information.
13. Provide the following product information for each component provided.
    a. Manufacturer's product name and number.
    b. Tag number (if applicable).
    c. Functional name.
    d. Description of construction and features.
    e. Performance data.
    f. Service requirements (power, environment, etc.).
    g. Dimensions.
14. Drawings shall be prepared using latest version of AutoCAD and shall be provided on hardcopy and CD-Rom media.

1.04 FINAL DOCUMENTATION

A. Provide the following Operation and Maintenance Manuals:

1. In printed form supplied in indexed, 3-ring binders (2 sets), and as electronic documentation on CD-ROM:
   a. Complete and detailed operating instructions for each hardware and software product.
   b. Complete and detailed maintenance instructions.
2. A list of all components to the module level.
3. All drawings.

B. Provide updated versions of all submittal information showing as-built conditions.

1.05 TRAINING

A. Provide operation and maintenance training for all hardware and software provided. Coordinate in accordance with the Contract Requirements including those included in General Conditions Specification -01664 "Training".

B. Training at the Manufacturer's Facility:

1. An allowance shall be provided for City personnel to attend standard courses.
2. The cost of travel, meals, and lodging for the city's personnel while attending training shall be paid from the travel and subsistence allowance.

C. Site Training: Provide two (2) five day training periods for up to eight City personnel for each period.

1.06 MAINTENANCE CONTRACT

A. At the end of the warranty period, the system will be added to the City's existing Alliance Maintenance agreement. An allowance for the full 12 month cost of this addition is included. Prior to final acceptance, the final cost will be prorated to coincide with the period of the existing agreement and paid as part of the final payment.

1.07 GUARANTEE AND WARRANTIES

A. Equipment, software, and materials that do not achieve design requirements after the installation shall be replaced to attain compliance at no addition cost to the City. Following replacement or modification, the Contractor shall re-test the component or loop and perform any additional procedures needed to place the complete system in satisfactory operation and attain approval from the Engineer.

B. The system shall be warranted for 12 months following acceptance. The warranty shall provide Foxwatch coverage which includes labor, material, and 24-hour technical support

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide all hardware and software necessary to meet the product and functional requirements of this Section and of the DCS requirements on the Drawings.

2.02 HARDWARE

A. A new remote communication module shall be added to the existing Foxboro DCS System at RM Clayton WRC. This module shall be added to existing DCS Cabinet as directed by the City of Atlanta. The intent of this addition is to provide a fully functional and complete communication link to the PLC inside the Local Control Panel at the North Fork Peachtree Creek project site (Electrical Building). The DCS system integrator shall field verify the availability of panel space prior to bidding.

B. The DCS system integrator shall include in the bid any additional hardware to facilitate communication between the existing Foxboro Plant Network and this new remote PLC communication interface. The DCS system integrator shall field survey the existing Foxboro DCS System at RM Clayton to determine the need for any additional communication hardware prior to bidding.

C. The DCS system integrator shall provide any additional DCS hardware as necessary to provide the functionality and performance as showing on the P&IDs and the specifications.

D. Provide all cables, connectors, and wire taps necessary to meet the requirements of this Section.

2.03 SOFTWARE

A. General:

1. Provide all software necessary for the required functions.
2. All software shall be completely debugged and operable prior to shipment. The City shall not be required to provide any programming effort to achieve a fully operational system.
3. System parameters (e.g., setpoints, alarm limits, and loop tuning constants) shall be entered or modified using a Workstation with a modular key board.

B. Operating Software

1. The operating software shall include the operating system and other standard software that supports the complete process control system.
2. No additional software packages are required for this project.
3. Provide all necessary licenses for required software packages for this project.

PART 3 - EXECUTION

3.01 GENERAL

A. In addition to other requirements herein, coordinate with others to effect the following.

1. Preliminary Submittals: Prepare loop wiring drawings based on the drawings provided as part of Specification Section 13200 – Control Panels.
2. Submittals and Final Documentation: Incorporate additional loop wiring drawing and I/O list information provided by the Section 13200 – Control Panels including wire and terminal numbers for signals and power. Incorporate additional loop wiring drawing and I/O list information provided by the Section 13200 Supplier including component calibration and connections to process and wire. Incorporate additional loop wiring drawing information provided by the Division 16 Electrical Supplier including wire connections, terminal numbers, and terminal junction boxes.
3. Product Delivery: Provide equipment handling and storage instructions.
4. Enclosure Installation: Provide enclosure installation instructions.
5. Enclosure Inspection: Verify proper enclosure installation.
6. DCS Component Installation: Install all DCS components including modules, cables, connectors, wire taps, operator interfaces, and fiber optic converters.
7. DCS Field Wire Installation: Provide signal cabling and power connection instructions.
8. DCS Field Wire Inspection: Verify proper signal cabling and power connection installation. Coordinate, and witness with the Contractor, the application of electrical power to all electric powered DCS components.
9. DCS Communication Link Connection: Make final wire and fiber optic connections to DCS components.
10. DCS Communication Link Inspection: Verify proper test procedures and results. Verify proper installation.
11. Coordinate with the Contractor for the following field testing.
    a. Operational
    b. Functional
12. Operation and Maintenance Manuals: Incorporate all loop wiring drawing as-built information from associated specification section suppliers.

3.02 SOFTWARE CONFIGURATION

A. The Section 13150 Instrumentation and Controls - Control Logics Descriptions are provided as functional requirements. Provide all software, programming, and configuration necessary to affect the required functions.

B. Standard function requirements are those required by article STANDARD FUNCTIONS hereafter.

C. Special function requirements are those required by the loop functional descriptions as supplemented by article SPECIAL FUNCTIONS hereafter and by standard functions.

D. The requirements herein shall be provided as configured functions. Creation and modification of the following items shall be effected with software directed (using menus, instruction displays, etc.) procedures and without code modification.

1. Input/output (I/O) configuration, assignments, and functions.
2. Content and functions of displays, reports, logs, and other hard copy items.
3. Manual entry changes including all manually entered values.
4. Automatic control functions.

E. DCS Graphics Conventions:

1. The DCS Graphics provided for remote monitoring of the Liddel Drive Equalization Facility shall be designed to be compatible with the existing graphical standards at the RM Clayton Plant. The DCS System Integrator shall generate a set of new DCS graphics to display a hierarchical sequence of displays including Equalization Facility Overview Graphic, individual Process Graphics, Process Alarm Summaries (can link to the standard Foxboro Current Alarm Display), Text Information Pages (Elapsed Motor Run Times, for instance), and update the existing Foxboro System Maintenance Graphics (can link to the standard Foxboro System Management Display). To facilitate the paging thru the hierarchical displays, a "display menu bar" shall be located on the left side of each graphic. Each graphic shall have a customized "display menu bar" to allow paging to the Overview Graphic, related Process Graphics, related Text Information Pages, or "previous display". The Foxboro configuration menu will be display at the top of the Operator Displays. Operator controls for PID controllers and motor control shall be implemented by utilizing pop-up Faceplate Overlays. Each Analog Measurement shall be configured for historical trending. On the Process Graphics, Historical Trends will be implemented as pop-up quarter- and half-screen Overlay Windows.
2. Each Process Graphic shall supply the operator with schematic representations of a specific process system, with live dynamic data displayed on top of a static background. Each graphic shall include dynamic text and graphical symbols that may be configured to change color, shape, or blink, given different states of the associated process variable. Indications of alarm conditions, safe conditions, and device status shall be accomplished by the use of color distinction and blinking attributes for each dynamic element on the display.
3. Standard COA Color conventions for Process Graphics are listed in the table below:

COLOR	MEANING
BLACK (0) TEXT	Static Text Information
BLACK (0) TEXT ON WHITE (15) BACKGROUND	Analog Measurement/Parameter
RED (1)	Running, On, or Open
RED (1) BACKGROUND	Value is Bad or Out-of-Range
GREEN (2)	Stopped, OFF, or Closed
CYAN (14)	System communication error
WHITE VALVE SYMBOL(15)	Intermediate (Between open and closed)
YELLOW (11)	Measurement in Alarm; Valve with 2 limit switches (open/closed) has both discretes true(1,1).
YELLOW FLASHING (27)	Unacknowledged Alarm
WHITE FLASHING	Previous Alarm Cleared but Unacknowledged
ORANGE	Hand/OFF/Auto Indication Lead/Follow/Standby Indication Switch Selection
BLUE RECTANGLE with a T	Trend Selection
INVISIBLE	Alarm not active
MAGENTA	Two Speed Motor - Running at low Speed
RED	Two Speed Motor - Running at High Speed
GREEN	Two Speed Motor - Stopped

4. The requirements herein shall be provided as configured functions. Creation and modification of the following items shall be effected with software directed (using menus, instruction displays, etc.) procedures and without code modification.

F. DCS Alarming:

1. All DCS generated alarms shall be displayed on the respective Process Graphic by the use of the Display Conventions listed above. These alarms shall be grouped in agreement with the City of Atlanta. Indication of active alarms in each alarm group shall be displayed at the top of the Operator displays and shall enable the Alarm LED on the associated annunicator keyboard graphic call-up button. High Priority alarms shall be audibly alarmed. The Operator can acknowledge the alarms by selecting the Alarm ACK button on the "display menu bar" or by pressing the predefined ACK button on the annunicator keyboard. Alarms shall be configured so that when selected from the standard Foxboro Current Alarm Display, the primary related Process Graphic will be "called up". Alarms shall be targeted for printing at Console A in the RM Clayton Administration Building or as otherwise directed by the City of Atlanta.

3.03 STANDARD SOFTWARE FUNCTIONS

A. Local/Remote/Enabled Terminology: The following convention is used for this project. "Local-remote" denotes proximity or distance from a point of control or indication. "Enable(d)" denotes the ability to control. If control is enabled at some location, conditions at that location may still disable manual or automatic control (for example, if the device has failed or is out-of-service). Provide a convenient method to determine the reason for each disabled mode. "Out-of-service" denotes that manual and automatic control of a device is manually disabled.

B. Out-of-Service: Provide manual out-of-service mode selecting for all control outputs.

C. Input/Output Lists: Standard and special function requirements apply equally for new equipment, existing equipment, and pseudo input points.

D. Process Graphic Displays:

1. Display the current status of discrete inputs. Indicate elapsed run time for motors with an on-off discrete input.
2. Digitally display the current value of analog inputs and outputs.
3. Display level analog inputs as a color level in a structure outline.
4. Provide manual control of outputs. Provide manual selection of manual or automatic mode where automatic control is required. Indicate the mode (enabled, disabled, manual, automatic, lead, lag, etc.) of outputs and other control functions. Indicate if equipment is out-of-service.
5. Display process related alarm conditions near, or as part of, a corresponding graphic symbol.
6. As a minimum, provide a sufficient number of process graphic displays to accomplish the control and monitoring of the processes as described in Specification Section 13150 Instrumentation and Controls - Control Logics Descriptions.
7. Notice that the process graphic displays do not include the following types of required displays.
   a. Process Tabular
   b. Alarm
   c. Trend
   d. Diagnostic
   e. System Configuration
   f. Help

E. Alarms:

1. Indicate the alarm source where there is more than one source; for example, a level alarm discrete input and an analog input alarm limit.
2. Where a fail discrete input alarm and a generated alarm are required for the same equipment, they shall be treated as separate alarms.

END OF SECTION 13500

Attachment A – New DCS Equipment

PART 1 - HARDWARE

3.01 DCS PANELS

A. DCS Panel XX:

DCS Panel Location	DCS Panel Name	IO Type	IO Module Model	# of Modules	# Points per module	Total Points Unused	Rail Location
RM Clayton WRC – specific location to be determining during Construction Phase	XX	Comm	FCM100E	1	2	0	A
Available Panel Space							
9" Rail Space							A
6" Rail Space							B
No available Space							C
No available Space							D

SECTION 13900
INSTRUMENTATION INSTALLATION GUIDELINES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The provisions and requirements of Division 13, Section 13000 "General Provisions" of this Specification shall apply to the work specified in this section.

C. Installation and Fabrication of Control Panels shall be as specified in Division 13, Section 13200 "Control Panels".

D. Furnishing of Field Instrumentation and miscellaneous devices shall be as specified in Division 13, Section 13300 "Instrumentation Specifications".

E. Field Instrumentation and Control Panels and/or other Cabinets furnished under this Specification shall be provided with transient surge and lightning protection as required in Division 13 Contract Specification 13270 "Surge and Lightning Protection".

1.02 SUMMARY

A. This Section provides general guidelines for the mounting and installation of field instrumentation, analyzers and other controls components associated with this contract.

B. Where applicable, Contractor shall utilize the attached installation details (if provided) as a basis for his field installation design. Where installation details are not provided nor applicable, the Contractor shall furnish appropriate mounting and interconnection hardware in accordance with the manufacturer guidelines and standard industry practices.

C. Furnish all labor, supervision, materials, equipment and incidentals required to install, complete and ready for operation, the instrumentation and controls as described in this section and in accordance the Division 13, Section 13000 "General Provisions" of these Contract Specifications.

1.03 REFERENCE STANDARDS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Reference Standards" and as specified herein.

1.04 QUALITY ASSURANCE

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Quality Assurance" and as specified herein.

1.05 PRIORITY OF THE CONTRACT DOCUMENTS

A. Provide in accordance with Division 13 Contract Specification 13000 Section "Priority of the Contract Documents" and as specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS

A. All materials of the same type shall be the product of one (1) manufacturer.

B. The materials used shall be new, unused and as hereinafter specified. All materials where not specified shall be of the very best of their respective kinds. Samples of materials or manufacturers product specifications shall be submitted for approval as required by the Engineer.

C. All current carrying cables, wires, buses, terminals, windings, parts, etc. shall be copper. Exception shall be made to this section is for circuits involving thermocouple circuits where the wiring, terminals and/or other current carrying parts shall be made from the same materials as that of the thermocouple.

D. Materials and equipment furnished shall be suitable in all ways for the intended application. Ratings shall match or exceed the requirements of the indicated Reference Standards, Drawings and Specifications.

2.02 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, instrumentation and control system enclosures shall have the following ratings.

1. NEMA 1 for dry, non-process indoor locations.
2. NEMA 12 for "DUST" locations.
3. NEMA 4X for outdoor locations, rooms below grade (including basements and buried vaults), "DAMP" and "WET" locations. Enclosure material shall be carbon steel with baked or electrostatically applied enamel finish, or stainless steel.
4. NEMA 4X for "CORROSIVE" locations. Enclosure material shall be stainless steel or fiberglass reinforced polyester (FRP). All FRP panels located in direct sunlight shall be provided with a protective coating to prevent discoloration and cracking.
5. NEMA 7 (and listed for use in the area classifications shown) for "Class I, Division 1"; "Class I, Division 2" and "Hazardous Locations". Enclosure material shall be cast malleable iron.
6. Refer to Division 16 Drawings for hazardous area classifications.
7. Installations in Outdoor areas require sun shields.

2.03 REQUIREMENTS FOR HAZARDOUS AREAS

A. All equipment, materials, and installation techniques used in areas designated as hazardous in the Specification Sections, or on the Contract Drawings shall be in strict accordance with National Electrical Code Articles 500, 501, 502, 503, and 504.

B. Unless auxiliary protective means as noted below are utilized, All equipment and materials that are supplied and intended to be safely operated and inheritable designed for used in hazardous areas shall be UL listed for the appropriate hazardous area classification.

C. Unless otherwise noted on the Contract Drawings, the Engineer intends that instrumentation and controls located in Electrically "Hazardous Locations" be inherently suitable (i.e. use of explosion proof NEMA 7 or NEMA 9 enclosures) to meet the electrical area classifications. Should the Contractor or Subcontractors provide instrumentation, auxiliary devices, or other control equipment that is not inherently suitable for intended environment; the design, implementation, or use of Intrinsic Safety barriers or other mechanical or electrical means of guaranteeing the suitability of the said instrumentation, auxiliary devices or other control equipment to safely operating in its intended environment shall only be implemented at the expense of the installer or supplier of said equipment. The supplier has the responsibility to coordinate with all other Contractors and Subcontractors affected to notify them of the impact and negotiate the sharing of the costs and other impact associated with the use of alternate designs.

D. The common engineering practice of the use of float level switches for monitoring the levels in sumps and other areas, which are often considered electrical hazardous, is an example of the implied intent of the Engineer in his design documents that the Contractor and/or his suppliers and/or subcontractors can be reasonably expected and required to provide additional materials and methods to make use of the specified device in what may well be a electrically "hazardous location". The Contractor and/or his suppliers and/or subcontractors may choose to use a more expensive device (that is inherently suitable for the intended location) in implementing the engineering design if he or she so chooses but at no time shall there be any additional cost or schedule impact to the Owner.

E. The use of Intrinsically Safety (IS) as an auxiliary protection means shall be designed, installed, and testing in compliance with the National Electrical Code Articles 500, 501, 502, 503, and 504. Additionally, the Intrinsic Safety design, installation, and testing shall comply with the following:

1. Devices utilized in Intrinsically Safe (IS) applications must be certified and stamped as being suitable for use in the intended area classification. Certifications of all IS devices shall be submitted along with the associated instrumentation and controls. Failure to submit proper certifications and/or IS Design calculations shall not constitute approval of the auxiliary protection means by the Engineer.
2. Zener Diode style IS Barriers must be grounded in compliance with National Electrical Code Article 504 and ISA Recommended Practice RP12.6. Provide at least AWG # 6 insulated Green Wire to a dedicated ground rod or grounding triad as necessary to get less than 1 ohm to ground resistance. Dedicated IS grounding system shall (and must) only be connected at one point to the plant ground grid (if grounding triad used, Connection to IS Barriers at one leg of triad and connection to plant ground grid from another leg of the triad should be used to guarantee a good and high quality path to earth ground).
3. Simple Apparatus (Switches, etc.) can be provided with Switch Amplifier type IS Barriers that do not require a dedicated IS Grounding connection to the IS Barrier.
4. Energy storing devices (i.e. transmitters, etc.), have Entity parameters that must be utilized in developing the IS Barrier design to ensure that installation will be suitable for the intended electrically "hazardous location". Vendor furnished Entity parameters and IS Barrier design calculations shall be submitted for approval in these applications.
5. IS Barriers should be located in an electrically non-hazardous area such that the incoming hazardous ISS wiring from field devices is electrical isolated at the IS barrier from the regular non-hazardous wiring leaving the IS Barrier.
6. IS wiring inside control panels shall be separated by 2 inches of air space from all regular non-hazardous wiring. All IS wiring inside enclosures shall be secured so that any

conductor that might come loose from a terminal cannot come in contact with another terminal. Grounded Metal or Isolated Partitions are permitted by NEC Code Article 504-30 with lesser distance requirements.

7. Wiring ducts in Control Panels containing IS circuits shall be colored light blue or identified with labels containing the wording "Intrinsic Safe Wiring" or the equivalent.
8. IS wiring shall be located in dedicated conduits separated from any non-hazardous wiring.
9. Conduits where above ground containing IS wiring shall be identified with labels containing the wording "Intrinsic Safe Wiring" or the equivalent per NEC Article 504-80.b. Spacing between labels shall be no less than every 25 feet.
10. IS wiring shall be color coded light blue where no other conductors colored light blue are used per NEC Article 504-80.c.
11. Conduits containing IS wiring where entering enclosures containing regular non-IS wiring shall be sealed to prevent possible transmission of gases from hazardous areas.

2.04 TRANSIENT SURGE AND LIGHTNING PROTECTION

A. General Requirements – Transient Surge and Lightning and protection shall be provided to protect all instrumentation and controls from induced voltages and power surges propagating along the analog or discrete signal and/or power supply lines or digital communication connection to the Control system and/or Telemetry system. The protection systems shall be such that the surge protective device shall not interfere with normal operation, but shall lower the induced voltage level or transient surge level to be less than the instrument's (or control device's) surge withstanding level, and shall be maintenance free and self-restoring, if possible. All connection points to be copper with nickel plating. The surge protective device should meet IEEE C-62-41 Standards.

B. Additional Requirements shall be as required in Division 13 Contract Specification 137270 – Surge and Lightning Protection.

C. The supplier of instrumentation and controls associated with this Division shall provide the appropriate surge protective device as required by this Division. Instrumentation and Controls Subcontractor shall provide any additional surge protective devices, materials, supervision, installation, and testing if the supplier of any instrumentation and controls under the Contract Specifications does not satisfy the intent of the Division 13 Contract Specification 13270 – Surge and Lightning Protection.

2.05 INSTRUMENTATION TUBING AND FITTINGS

A. All instrument air header takeoffs and branch connections less than 2-in shall be 316 stainless steel or copper as noted in the mechanical (piping) specifications.

B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the Mechanical (piping) specifications and all instrument installation details. Instrument fittings and valves shall be match the predominant standard at the existing facility unless other specified in the mechanical (piping) specifications.

C. Unless otherwise specified in the mechanical (piping) specifications, all instrument tubing shall be fully annealed ASTM A269 Seamless 316 grade free of O.D. scratches having the following dimensional characteristics as required to fit the specific installation:

1. 1/4-in to 1/2-in O.D. x 0.035 wall thickness.
2. 5/8-in to 1-in O.D. x 0.049 wall thickness.
3. 1-in O.D. x 0.065 wall thickness.
4. 1-1/4-in O.D. x 0.065 wall thickness.
5. 1-1/2-in O.D. x 0.083 wall thickness.
6. 6. 2-in O.D. x 0.095 wall thickness.

D. All process connections to instruments shall be annealed 1/2-in O.D. stainless steel tubing, Type 316.

E. All tube track shall be supported by stainless steel and installed as per manufacturer's installation instructions.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Instrumentation and Controls Subcontractor, acting through the Contractor, shall coordinate the installation, the placing and location of system components, their connections to the process equipment, panels, cabinets, and devices; subject to the Engineer's approval. He shall be responsible to ensure that all field wiring for power and signal circuits are correctly done in accordance with best industry practice and provide for all necessary system grounding to ensure a satisfactory functioning installation. The Instrumentation and Controls Subcontractor hereunder shall schedule and coordinate his work under this section with that of the electrical work specified under applicable Sections of Division 16. Additionally, the Instrumentation and Controls Subcontractor hereunder shall schedule and coordinate his work under this section with that of the mechanical work specified under applicable Sections of Divisions 11 and 15.

B. The Instrumentation and Controls Subcontractor shall coordinate his work with the work of the different trades so that interferences between instrumentation, control panels, conduits, piping, equipment, and architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the Contractor and/or his subcontractors without additional expense to the Owner. In case interference develops, the Engineer is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

C. Redesign of instrumentation, electrical, or mechanical work, which is required due to the Contractor or subcontractor's use of an alternate item, arrangement of equipment, and/or layout other than specified herein, shall be done by the Contractor or subcontractors at his own expense. Detailed plans of the redesign shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his own or others, caused by such redesign.

D. The Drawings are not intended to show exact locations of instrumentation, control panels, or other pieces of equipment. The Contractor, at his discretion, may relocate instruments to a more appropriate location within 5 feet of the location shown on the Contract Drawings. Exact locations shall be as approved by the Engineer during construction. Obtain in the field all information relevant to the placing of the instrumentation and controls work, and in case of any

interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

E. Verify with the Engineer the exact locations and mounting heights of any instrumentation, control panels or other furnished devices that requires regular maintenance or operator access for the safe operation of the process and associated equipment.

F. Unless otherwise directed by Engineer or Owner, Field instrumentation shall be mounted so that instrument is located between 48 inches (4 Feet) and 60 inches (5 Feet) above the finished surface of the floor or access platform. Instrumentation shall be mounted for ease of access without obstructing walkways or access to other equipment. Mounting locations shall be in agreement with the manufacturer installation guidelines to ensure normal and safe operation.

G. Surface mounted instrumentation, control panels, junction boxes, and other devices provided under this division shall be mounted to stainless steel channel (minimum 1 inch) to provide a clearance between surface/wall and equipment. Mounting hardware and brackets required to support this equipment shall be provided as part of the Contract. Installation shall be performed in a workmanlike manner and shall not interfere with the operation and maintenance of any other equipment.

H. Floor mounted instrumentation mounting stands, analyzer cabinets, control panels, and other devices provided under this division shall be anchored to and placed on top of housekeeping pads to prevent incidental damage to said equipment during normal operation and housekeeping of the facility.

I. Control Panels and mounting of Field Instrumentation shall be designed in accordance with the Seismic Zone associated with the project as noted in the Contract Drawings.

J. Instrumentation and Controls furnished under this Division shall be factory and/or "bench" calibrated prior to installation.

K. Instrument enclosures shall be provided and installed, with appropriate sunshields, heaters, cooling, insulation, etc., as needed to keep the equipment within its manufacturer's recommended operating conditions under all modes of operation and changing ambient conditions. As a minimum, sunscreens shall be provided for all enclosures which house microprocessor based electronics and are located out-of-doors.

L. All process, pneumatic, and electrical connections to furnished instrumentation and other controls shall be made as required, and in accordance with the manufacturer installation instructions and with the approved shop drawings.

M. Instrumentation and miscellaneous hardware and accessories shall be installed in accordance with the manufacturer's instructions and with the appropriate instrument installation details as provided with this Contract.

N. The instrumentation installation details on the Contract Drawings indicate the intended installation method for the instruments specified. Where specific installation details are not specified or shown on the Drawings, standard industry practices like the American Petroleum Institute (API) Recommended Practice 550 shall be followed as applicable.

O. Unless specifically shown in the Contract Drawings, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or pipe stands. All instrumentation process and instrument air connections shall be provided with shutoff and drain valves. For differential pressure transmitters, valve manifolds for calibration, testing, and blow down service shall also be provided. For slurries, chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

P. All field mounted instruments, analyzers or control panels having operator controls, local indicators, or recorders shall be installed and orientated to allow operator access and/or to make the indicator scale or chart visible from adjacent areas. Rotate indicating portions of instruments where necessary to improve visibility from adjacent areas. Operator access to control panels shall comply with industry safe operation practices and OSHA guidelines.

Q. Field Installations shall provide sufficient clearance for normal operation and maintenance access to all installations including dismantling of the instrumentation, disconnection of process and instrument air connections, and/or associated wiring.

R. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors, and shut-off valves. All instrumentation tubing shall be rigidly mounted and supported using tubing raceways, supports and tie downs as required. Instrumentation tubing shall be indirectly mounted to walls or columns using stainless steel channel to provide a minimum of 1 inch spacing. Plastic tubing or rubber hoses can be utilized (when process conditions allow) for the last 5 feet of connection to instruments where excessive vibrations shall be found. Installation shall be performed in a workmanlike manner and shall not interfere with the operation and maintenance of the associated instrument or any other equipment.

S. Field instruments requiring AC power supply shall be provided with local electrical shutoffs and fuses as required.

T. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded as directed by the manufacturer of the instrumentation equipment but in no case shall more than one ground point be employed for each shield.

U. Installation of Fiber Optic Cable. Refer to cable manufacturer's specifications for bend radius. Use cable breakout assembly as recommended by the cable manufacturer. Provide wire basket, strain relief as required to meet manufacturer's strain requirements.

V. Lifting rings from cabinets/assemblies shall be removed. Hole plugs shall be provided for the holes of the same color as the cabinet.

W. The P&IDs and Contract Drawings indicate the intent of the interconnection between the individual instruments. At the time of field installation, any corrections or exceptions should be noted. Two complete sets of approved shop drawings shall be kept at the job site during all on-site construction. Both sets shall be identically marked up to reflect any modifications made during field installation or start-up. All markings shall be verified and initialed by the Engineer or his designated representative.

X. Following completion of installation and the operational readiness testing, one set of the marked up drawings shall be provided to the Engineer, the other retained by the Supplier for incorporation of the mark-ups into final as-built documentation.

Y. All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Supplier shall bear full responsibility for such violations and assume all costs arising there from.

Z. Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust, and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged units or systems shall remain on site and returned to the manufacturer after the replacement units or systems have been delivered to the site. Under no circumstances will instrumentation or controls equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied, and all costs associated with replacement shall be borne by the Contractor.

AA. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer. The entire damaged enclosure panel or section shall be repainted per the field painting specification Section 09902, at no additional cost to the Owner.

3.02 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner or clean lint-free rags. Do not use compressed air.

END OF SECTION 13900

SECTION 13940
COMMUNICATION LINKS

PART 1 - GENERAL

1.01 SCOPE

A. Requirements of Section 13000 Instrumentation and Controls – General Provisions form a part of this Section.

B. Provide fiber optic and wire communication links to interconnect components of the Plant Control System – SCADA (Signal Conditioning and Data Acquisition) System. See the Plant Control Systems Network Drawing (Dwg, I-002) for additional communication link requirements, including equipment locations and quantities.

C. Items provided under this Section are installed in enclosures provided under Section 13200, Control Panels and in wire ways provided under Division 16, Electrical or existing.

D. Provide all cables, patch cords, connectors, terminators, wire labels and sleeves, network switches or repeaters, bridge devices, patch panels, and any other accessory or incidental as required for a complete and fully functional process control and monitoring system as described in the Contract Drawings and Specifications including functionality shown on the P&ID Drawings (I-101, I-102, I-103, I-104, I-105, I-106, I-107, and I-108) and Control System Network Drawing(s) (I-002).

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer installation recommendations for all products. Provide complete installation procedures that will be followed for this work.
2. Test procedures prior to testing. Provide test documentation after testing.
3. Training procedures prior to training.
4. Catalog cut sheets.
5. Communication cable routing plans and cable termination schedule for approval by the Owner. Include location of all terminations including patch panels and protection method of cables that are located in conduit, duct banks, and/or cable tray. Routing information shall be included in final as-built drawings.

1.03 FINAL DOCUMENTATION

A. Provide final documentation required by Section 13000.

B. Provide all test documentation.

1.04 TRAINING

A. Provide one day of training for City personnel during installation. Provide one day of training for City personnel during post-installation testing.

PART 2 - PRODUCTS

2.01 FIBER OPTIC COMMUNICATION LINKS

A. Fiber Optic Cable:

1. Each cable shall contain a minimum of 12 functional fibers after installation, connection, and testing are complete.
2. Fiber shall be a multimode, graded index, solid glass waveguide, and shall be coated to preserve the intrinsic strength of the glass. Each fiber shall be color coded. Fiber shall have the following characteristics:

Core diameter:	62.5 microns
Cladding diameter	125 microns
Refractive index delta	2.0 percent
Numerical aperture (NA)	0.275
Attenuation at 1300 nm	1.0 dB/km maximum
Bandwidth at 1300 nm	500 MHz/km minimum
Attenuation at 850 nm	3.75 dB/km maximum
Bandwidth at 850 nm	160 MHz/km minimum

3. Cable shall include a buffer tube surrounding the fibers, one or more strength members, and an outer jacket. Cable components shall be of continuous material with no factory splices, holes, blisters, or other imperfections. Cable shall have the following characteristics:

Material	non-metallic
Tensile load rating	600 lb minimum, long term
Bend radius rating	5 inches maximum unloaded (0-180 lb); 10 inches maximum loaded (181-600lb)
Diameter	0.5 inches nominal

4. Buffer tube shall allow for free fiber movement and thermal expansion. Buffer tube shall be flooded internally with a gel compound to prevent fiber contamination and freezing stress from moisture.
5. Strength members shall protect fibers from mechanical stress during installation and required service.
6. Cable shall be for outdoor installation in conduit.
7. Fiber optic cable shall be AT&T, Type 3DNX-018-HXM; or equal.

B. Fiber Optic Connectors:

1. Provide a connector on each end of each fiber.
2. Type: ST (bayonet twist-lock keyed).
3. Typical attenuation: 0.2 dB.

4. Maximum attenuation: 0.4 dB.
5. Loss repeat: less than 0.2 dB per 1,000 reconnects.
6. Fiber optic connector shall be AT&T, model P2020C-C-125; or equal.

C. Fiber Optic Patch Panels:

1. Provide a patch panel at fiber optic cable termination as shown on the Drawings.
2. Patch panel shall include coupling panel(s), bayonet/threaded couplings, and a lockable door. Patch panel shall totally enclose the connectors and patch cords. Provide 19-inch rack mounting brackets.
3. Fiber optic patch panel shall be AT&T, model 200A LIU; or equal.
4. Coupling panel shall be AT&T, model 10A; or equal.
5. Couplings shall be AT&T, model C2000A-2; or equal.
6. Mounting bracket shall be AT&T, model 742A; or equal.

D. Fiber Optic Patch Cords:

1. Provide patch cords to interconnect two cable fibers between panels (pass through jumper) or to connect cable fibers to converters as indicated on the Block Diagram. Each patch cord shall have 2 fibers for 2 direction communication.
2. Patch cord fibers shall be 62.5-micron with associated attenuation and bandwidth parameters as specified. Each fiber shall have an individual thermoplastic tight buffer tube, strength member, and a thermoplastic jacket.
3. Provide a minimum of 20 percent spare or 2 spare patch cords, whichever is greater, of each type and length.
4. Fiber optic patchcords shall be AT&T, model FL2E-E; or equal.

E. Fiber Optic Splice Enclosures:

1. Fibers shall not be spliced except where specifically approved in writing by the Engineer. The following shall <u>not</u> be acceptable reasons for splicing fibers: cable length availability or cost; cable installation convenience or cost.
2. If used, splice enclosures shall protect spliced fibers from moisture, soil, strain, or other damage. At each splicing location, sufficient cable length shall be provided to properly rack and splice the cables and to allow for additional future splices.
3. Ground splice enclosures to earth per Division16, Electrical.
4. Fiber optic splice enclosure shall be AT&T, Model 2600LG; or equal.

2.02 WIRE COMMUNICATION LINKS

A. Foxboro Fieldbus Extension Cable:

1. Cable shall be 20 AWG, stranded, shielded (copper braid with 100% coverage) twin-axial cable with polyethylene insulation and PVC jacket.
2. Cable shall be Belden 9207; or equal.

B. Allen Bradley Data Highway Plus Cable:

1. Cable shall be 20 AWG, stranded wire, shielded (foil shield with copper drain wire giving 100% shield coverage) twin-axial cable with polyethylene insulation and PVC jacket.
2. Cable shall be Belden 9463; or equal.

C. RG-11 Ethernet Cable:

1. Cable shall be triax cable, RG-11/U type, 14 AWG solid bare copper wire, foam polyethylene insulated with polyethylene jacket, 2 bare copper shields with polyethylene insulation between shields, nominal O.D. of .475 inches.
2. Cable shall be Belden No. 8233; or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Provide all equipment, instrumentation, and supplies necessary for installation.
2. Remove wire from existing wire ways as required.
3. Install fiber optic communication links to ensure a minimum number of splices. Fiber splices shall be made only with written approval from the Engineer prior to implementation. Wire conductors shall not be spliced.
4. Provide a minimum of 5 feet spare cable (fiber optic and wire) coiled at each cable access point (manholes, handholes, and trenches).
5. Provide cable supports in manholes and hand holes according to requirements in Division 16, Electrical. Existing cable supports may be used where available and not damaged.
6. Tag all cables, fibers, and conductors according to Division 16, Electrical, Section 16120, Conductors. Provide tag documentation.
7. Pull a 200-pound tensile strength polyolefin cord through each conduit where cable is pulled.
8. Install all cable according to manufacturer recommendations. Pull all cable through conduit at the same time. Do not exceed the manufacturer recommended pulling tension. See Division 16, Electrical, Section 16120, Conductors for additional requirements.

B. Fiber Optics:

1. Demonstrate to the Engineer that manufacturer installation recommendations are strictly followed for all fiber optic components.
2. Fiber optic cable fibers shall be "fanned out" and each individual fiber shall be sleeved over with a Kevlar reinforced furcation tube. At the convergence point of all furcation tubes, provide fiber strain relief with a fan-out collar. Provide fiber strain relief at each connector. Provide cable gel blocking. Provide dust caps on each fiber connector until final assembly. Provide dust caps on each connector that is not coupled.
3. Attenuation for a single fiber optic connection point (connector through coupling through connector) shall be 0.7 dB maximum.

4. Where fiber optic splices are necessary and approved, fibers shall be fusion spliced. Attenuation for a single splice shall be 0.2 dB maximum. Test each splice with an Optical Time Domain Reflectometer (OTDR) bi-directionally to verify compliance at the time of splicing. Splices not conforming to these specifications shall be redone to meet specifications. Provide cable moisture protection during splicing operations.

5. Attenuation for each fiber optic link shall be 13 dB maximum, as required for a minimum gain margin of 4 dB. The gain margin is the decibel difference between the gain of the fiber optic converters and the loss budget of the fiber optic link (fiber optic cables, connectors, patch cords, and splices).

3.02 TESTING

A. Provide all equipment, instrumentation, and supplies necessary for testing. The Engineer shall have the option to witness and actively participate in the on-site tests.

B. Fiber Optic Pre-installation Testing: Prior to installing each cable, provide an Optical Time Domain Reflectometer (OTDR) test for each fiber at 1300 nm wavelength on the shipping spool. The OTDR test shall verify that each fiber meets the manufacturer attenuation specifications and that the cable was not damaged during shipping. Provide hard copy test documentation, including traces. Obtain approval from the Engineer prior to cable installation.

C. Fiber Optic Post-Installation Testing:

1. After cables and connectors are installed, OTDR test each fiber in both directions at 1300 nm wavelength. Provide hard copy and diskette test documentation.

2. After patch cords and couplings are installed, end-to-end attenuation test each fiber between transceiver connectors in both directions at 1,300 nm wavelength. Use a stabilized light source and an optical power meter. Provide test documentation, including reference power reading.

3. Provide test documentation relative to Specification Section 13400, Suppliers of Programmable Controllers shall including detailed specifications for all cables and connectors used.

4. Provide test documentation to the Section 13500, DCS supplier including detailed specifications for all cables and connectors used.

D. Fiber Optic Test Documentation: Test documentation shall include cable and fiber identification; fiber length; test direction; test wavelength; traces; fiber attenuation; attenuation breakdown for each fiber segment, connector, and coupling; and splice attenuation if applicable.

E. Wire testing: Test wire per Section 16999, Acceptance Testing and Calibration of Division 16, Electrical.

END OF SECTION 13940

SECTION 14600
BRIDGE CRANES AND HOISTS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete design and installation of all double girder bridge cranes, trolleys, hoists, and accessories. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related Work specified elsewhere:

1. Section 05120 - Structural Steel.
2. Section 09900 - Painting.
3. Section 16150 - Electric Motors.

D. All Bridge Cranes specified herein shall be supplied by the same manufacturer.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's warranty per the requirements of paragraph 1.05.
2. Manufacturer's certification
3. Design calculations verifying drive and hoists' horsepower; braking and energy dissipation requirements; end stop bumper energy dissipation and maximum force; bridge deflections; rail clam requirement and structural loading on run-way. Specific calculations for operation and deflections due to wind for outdoor cranes shall be included. Calculations shall be sealed by a professional engineer registered in the state of Georgia.
4. Detail of wheel loadings on runway system including number and spacing of wheels, number of drive units and end trucks and end truck spacing.
5. Shop drawing showing clearance dimensions, limits/extent of hook coverage and details of construction including general arrangement, runway, crane rail, complete bridge crane, cables, cable lifting devices and hardware and all product data required for the complete bridge crane installations.

6. Electrical wiring and control diagram, cables, near hatch retention device, cable lifting devices and associated hardware and manufacture product data for hoist.
7. Shop drawings shall be prepared by the equipment manufacture and not sales representatives or fabrication shops
8. Detail drawings showing all connections to support structures.
9. Materials specifications and mill certificates for bridge components.
10. Motor manufacturer cut sheets and literature including bearings, mechanical and electrical components.
11. Operation and maintenance manuals.

1.03 QUALITY ASSURANCE

A. Reference Standards:

1. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:
   a. NEC, National Electric Code.
   b. NEMA, Standards of National Electrical Manufacturers Association.
   c. OSHA, Occupational Safety and Health Act.
   d. ANSI, American National Standards Institute.
   e. ASTM, American Society for Testing Materials.
   f. AISI, American Iron and Steel Institute.
   g. NFPA, National Fire Protection Association.
   h. AWS, American Welding Society.
2. Comply with the Crane Manufacturer's Association of America (CMAA) Standards as specified below:
   a. CMAA Specification No. 70 for electric overhead traveling cranes.
   b. All hoists shall be designed for Service Class H4 as described in the Hoist Manufacturer's Institute (HMI) Specifications.
   c. All electrical and control components shall conform to NEC 610.

B. Experience: Equipment furnished under this Section shall be of a design and manufacture that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications. Provide a list of such installations complete with installation description, contact names, addresses, and telephone numbers. This reference list shall be submitted with the shop drawings.

1.04 QUALITY STANDARDS

A. The bridge cranes, monorails, trolleys, and hoists shall be furnished by a single manufacturer who shall assume sole responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the Drawings.

B. The Contractor shall assign unit responsibility to the crane manufacturer for all equipment specified in this section. The assignment of responsibility shall not be construed as relieving the Contractor from overall responsibility for this portion of the Work.

C. Manufacturer shall provide written certification that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions.

D. Manufacturers:

1. Kone Cranes
2. Gajjar Engineering
3. Or Equal

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 GENERAL

A. Supports and Auxiliaries: Crane assembly shall include all overhead track, trolley, hoist, end stops, and other track accessories as required for a complete system.

B. Runway beams, brackets, and associated framework shall be furnished and installed by the Contractor in compliance with the requirements of Section 05120 - Structural Steel and as shown on the Drawings.

C. Design Parameters

1. Design of traveling crane assembly shall be based upon the use of a safety factor of 5, applied to the capacity for all load bearing parts of the crane, hoist and trolley. The safety factors shall be based upon the ultimate strength of the materials used.
2. Design calculations for all structural members shall include all live and dead loads and all live and dead load impacts and shall be carried out in accordance with the methods stipulated by the CMAA.
3. Bridge girder deflection shall not exceed 1/888 of the span.

D. Wiring: All wiring and wire sizes shall be in accordance with the latest issue of the National Electrical Code

2.02 SERVICE CONDITIONS

A. The crane equipment shall be rated NEMA 4X stainless steel.

2.03 BRIDGE CRANES

A. General Requirements: Structural steel used in fabricated parts shall conform to requirements of Crane Manufacturers Association of America (CMAA) and ASTM A36. All shop welding shall

be in conformance with the American Welding Society. All anchor bolts shall be 316 stainless steel conforming to the requirements of Section 05120 – Structural Steel. The equipment furnished under this section shall comply with the requirements of ANSI B30.2.0g, Safety Code for Overhead and Gantry Cranes.

B. Assembly: As far as possible, all parts shall be assembled and shop-tested under no-load conditions. Upon disassembly all parts shall be match marked to facilitate erection.

C. Crane and Hoist Schedules:

DESIGN PARAMETERS	BRIDGE	TROLLEY	HOIST
DIVERSION PUMP STATION WET WELL AREA CRANE			
Rated Capacity, lbs.	20,000		20,000
Bridge Crane Span	34'-3"		
Type	Top running - Double girder -		
CMAA Classification	C		
Min. Available Vertical Hook Travel, Ft			54
Services	Outdoor	Outdoor	Outdoor
Full Load Speed, FPM	0 - 100 fpm	0 - 50 fpm	0-25 fpm
Speed Point	Variable	Variable	Variable
Power Supply	460/3/60	460/3/60	460/3/60
Control Voltage, Volt	115	115	115
Motor Speed, RPM	1,800	1,800	1,800
Motor Enclosure Type	TEFC	TEFC	TEFC
Motor Rating (min)	Continuous	Continuous	Continuous
Motor Brake Type	Disc	Disc	Disc & Regenerative
Motor type	Sq. Cage	Sq. Cage	Sq. Cage
Motor insulation (class)	F	F	F
Control Brake Type	Dynamic	Dynamic	Dynamic
Control Type	VFD	VFD	Magnetic
DIVERSION PUMP STATION VALVE ROOM CRANE			
Rated Capacity, lbs.	8,000		8,000
Bridge Crane Span	25'-0"		
Type	Underhung - Double girder		
CMAA Classification	C		
Min. Available Vertical Hook Travel, Ft			15
Services	Indoor	Indoor	Indoor
Full Load Speed, FPM	0 - 100 fpm	0 - 655 fpm	20/3.3 fpm
Speed Point	Variable	Variable	2-speed
Power Supply	460/3/60	460/3/60	460/3/60
Control Voltage, Volt	115	115	115
Motor Speed, RPM	1,800	1,800	1,800
Motor Enclosure Type	TEFC	TEFC	TEFC

Motor Rating (min)	Continuous	Continuous	Continuous
Motor Brake Type	Disc	Disc	Disc & Regenerative
Motor type	Sq. Cage	Sq. Cage	Sq. Cage
Motor insulation (class)	F	F	F
Control Brake Type	Dynamic	Dynamic	Dynamic
Control Type	VFD	VFD	Magnetic
JET MIX PUMP STATION PUMP ROOM CRANE			
Rated Capacity, lbs.	10,000		10,000
Bridge Crane Span	38'-2"		
Type	Underhung - Double girder		
CMAA Classification	C		
Min. Available Vertical Hook Travel			40'-4"
Services	Indoor	Indoor	Indoor
Full Load Speed, FPM	0 - 100 fpm	0 - 50 fpm	0-25 fpm
Speed Point	Variable	Variable	Variable
Power Supply	460/3/60	460/3/60	460/3/60
Control Voltage, Volt	115	115	115
Motor Speed, RPM	1,800	1,800	1,800
Motor Enclosure Type	TEFC	TEFC	TEFC
Motor Rating (min)	Continuous	Continuous	Continuous
Motor Brake Type	Disc	Disc	Disc & Regenerative
Motor type	Sq. Cage	Sq. Cage	Sq. Cage
Motor insulation (class)	F	F	F
Control Brake Type	Dynamic	Dynamic	Dynamic
Control Type	VFD	VFD	Magnetic

D. Then crane design shall maximize the hook coverage areas and heights within each location. The limits specified on the drawings are the minimum coverage requirements acceptable.

E. Other Electrical Equipment: The following electrical equipment shall be provided for the bridge cranes specified herewith:

1. Magnetic mainline contactor.
2. Fused manual safety switch.
3. Thermal overload protection.
4. 4 Runway current collectors - double shoe. (3 collectors plus dedicated ground).
5. Hoist geared upper and lower limit switch.
6. Anti Collision Banner photo eyes.
7. Wind meter, alarm and strobe for outdoor cranes (OSHA required).

2.04 CRANE TROLLEY REQUIREMENTS

A. Trolley Frame: Trolley frame shall be of all steel welded construction and shall be of the top running type. The frame shall be rigidly braced to maintain proper squareness.

B. Trolley End Trucks: Trolley end trucks shall be of welded steel box construction. Trolley end trucks shall be designed to prevent excessive drop in case of machinery breakage.

C. Trolley Bumpers: Bumpers shall be provided at the four corners of the trolley. Bumpers shall be equal to Wampfler Polyurethane.

D. Trolley Wheels: Trolley wheels shall be 12-inch in diameter with a total of four per trolley. Wheels will be double flanged with flat treads. Wheel material shall be forged steel, 58 RC (minimum).

E. Trolley Rail: 60# ASCE rail shall be used and shall be fastened to the top of the girders by welded rail clips.

F. Trolley Wheel Axle Bearings: Bearings shall be spherical roller type, with minimum L-10 bearing life of 10,000 hours. Bearings shall operate on rotating axles.

G. Trolley Drive: The trolley shall be motorized with an AC disc type brake. An A-1 modified trolley drive per CMMA shall be provided. Two trolley wheels shall be driven one, on each side of the trolley.

2.05 BRIDGE CRANE REQUIREMENTS

A. Runway Rails: The runway rails shall be straight, parallel, level, and at the same elevation as required to satisfy CMAA requirements specified herein and shown on the Drawings. Material shall be as specified in the Section 05120 - Structural Steel. The distance center to center and the elevation as measured at running surface of rail or flange shall be within a tolerance of plus or minus 1/8 inch. The runway rails shall be standard ASCE rail sections of the size recommended by the manufacturer and shall be provided with rail splices. (See Section 2.11)

B. Bridge Girders: Bridge girder assemblies shall be constructed of a fabricated structural section or welded plate box as required to provide full unobstructed crane movement above all mechanical equipment shown on the drawings. The girder assemblies shall be designed to the latest specifications of the Crane Manufacturers Association of America. Under full load, girder assemblies shall not deflect in excess of 1/888 of the span.

C. Bridge End Trucks: End trucks shall be of welded steel box construction with ample sized gusset plates for connection to the crane girders. Bridge end trucks shall be designed to prevent excessive drop in case of machinery breakage.

D. The bridge crane end trucks shall have steel wheels hardened to 375 to 425 Brinell mounted on a lifetime lubricated antifriction bearings fitted with seals to exclude dust and moisture. Wheel bases shall be 1/7 of the bridge span or greater. Axles and wheels shall be removable without disturbing other truck elements.

E. Bridge Bumpers: Bumpers shall be provided at the four corners of the crane and shall be equal to Wampfler Polyurethane. Crane shall be equipped with anti collision device to prevent crane-to-

crane contact or crane to end stop contact. Safety lugs shall be provided to limit the drop of the end truck to 1-inch or less in the event of a wheel or axle failure.

F. Bridge Wheels: Bridge wheels shall be 12-inch in diameter with a total of four per crane. Wheels shall be double flanged with taper tread drive wheels and flat tread idler wheels. Wheel material shall be forged steel, 58 RC (minimum).

G. Bridge Wheel Axle Bearings: Bearings shall be spherical roller type, with minimum L-10 bearing life of 10,000 hours bearings will operate on rotating axles.

H. Bridge Drive: An A-4 bridge drive shall be provided. If a dual motor system is used, the operation of the end trucks shall synchronized to assure even bridge travel without binding, jerking or excessive vibrations. Motors shall be reversible

I. Bridge drive reducers shall be at each end truck and shall be helical gear type. The gear motor assembly shall be provided with an electric brake rated at 100 percent of the full load motor torque.

2.06 HOIST REQUIREMENTS

A. Hoist Assembly

1. Hoist shall be of the wire rope type, HMI class H4 service.
2. Provide geared upper and lower limit switches and assure positive stopping under all conditions. An overload cutoff device shall also be provided.
3. Hoist Reeving: The Diversion Pump Station Pump Removal Crane BC0101 hoist shall be of double line reeving, at least 2 part and shall provide a true vertical lift. Other hoists can be single or double reeved to suit the lifting conditions. Hoist drum shall be of steel construction and shall be grooved to hold entire cable length in a single layer. Hoist shall utilize energy dissipating regenerative braking system.
4. Hoisting Rope: The hoist rope shall be of 316 stainless steel and shall be able to lift equipment the height specified, with a breaking strength at least five times the rated load capacity of crane. The ratio of the drum diameter to the type of stainless steel cable diameter shall be according to CMAA and WRTP recommendations, but rope diameter shall not be less than 20 mm.
5. Hoist Gear Box: All hoists gearing shall be in a totally enclosed gearbox. Gearing shall conform to AGMA standards and shall be heat treated, hardened steel, helical type running in an oil bath. Gearbox bearings shall be anti-friction type and have an L-10 bearing life of not less than 10,000 hours. Gearboxes shall be designed for easy draining and replacement of lubricating oil.
6. Running Sheaves: All running sheaves shall be of steel construction.
7. Hook Blocks: All hook blocks shall be of the safety type with all sheaves guarded and equipped with ball thrust bearings and forged steel hooks. Hook shall be equipped with a safety latch.
8. Sheaves shall be of heavy pattern, deep flanged and grooved and shall be either bronze bushed or fitted with ball bearings and supported on fixed pins.

9. Hoisting Unit: The hoisting unit shall be a packaged type hoist as manufactured by Yale or equal.

2.07 MOTORS

A. Motors shall be capable of handling full rated load for the full lift, or travel, at all rated speeds without overheating of the motor or controls. All motors shall be sized to operate at a maximum of eighty percent (80%) of rating when moving one hundred percent (100%) of rated load.

B. Motors and horsepowers shall be established by the crane manufacturer. No hoist motor shall be loaded beyond eighty percent (80%) of its rated capacity disregarding cable, sheave, gear and bearing friction.

C. Couplings: All motor couplings shall be of the flexible type.

D. Provide motor space heaters for all drives and hoist motors to allow operation at lowest winter temperatures and prevent condensation buildup between operations.

E. Outdoor cranes shall be supplied with two 250 watt metal halide down lights, one on each side of the hoist. The lights shall be powered from the bridge crane and not require a separate power supply. The lights shall be controlled from the operator's pushbutton station.

2.08 CONTROLS

A. Hoist Limit Switch: The hoist limit switch shall be so designed that when the hoist block reaches its upper limit of travel the hoist limit switch will either directly, or indirectly through a magnetic contactor or other device, interrupt the current to the hoist motor in the hoisting direction and allow the hoist motor brake to set. The limit switch shall be connected to the circuit in such a manner that it will be possible to lower the hoist block by reversing the controller into the lowering position.

B. Controls:

1. Crane control pendant shall be of NEMA 4X rated enclosures.
2. Main point of control for the cranes shall be from an eight (8) pushbutton pendent suspended from an independent trolley track running the length of the bridge.
3. A hand held radio remote control consisting of one receiver and two transmitters shall also be provided for the Diversion Pump Station Pump Removal bridge crane BC0101. The operation of the crane and associated hoisting equipment shall be operated either by the pushbutton pendent or the remote control. A mutual lockout shall be provided between pendant and remote control.

2.09 PAINTING AND PROTECTIVE COATING

A. All steel items including girders, end truck frames and trolley decks shall be power tool cleaned and shop painted in accordance with Section 09900 – Painting. Bridge crane manufacturer shall provide touch up paint for the Contractor. Touch up paint shall be compatible with the finish coats applied in the shop. Finish color shall be of the safety yellow machinery type.

2.10 NAMEPLATES AND WARNING SIGNS

A. Nameplates shall be permanently attached to the bridge crane systems. Capacity shall be stated in tons of 2,000 lbs. Nameplates shall be clearly legible and shall contain manufacturer's name. Warning signs shall be provided in accordance with ANSI B30.16, Chapter 16-2, affixed to bottom lift blocks.

2.11 ACCESSORIES

A. The bridge crane manufacturer shall provide and install the following accessories:

1. Runway Rail System: Runway rail shall consist of #60 ASCE rail. The runway rails shall be installed on the top of the structural support beams. The rail system shall include all hook bolts, splice plates, and all necessary mounting hardware as required to attach and properly align the runway rails. The length of rails shall be as shown on the Drawings.
2. Electrical Conductor System: The electrical conductor system for the bridge crane shall be a 160 feet, 4 wire Insul-8 conductor system consisting of 640 lineal feet of conductor, insulated dead end assembly, insulated hangars, clip hangers, collector with weather cuff, intermediate supports and end supports. The system shall be mounted adjacent to the bridge crane runway rails. The system shall be fed from a 480 volt, 3-phase, 100-amp electrical service and shall include all necessary mounting hardware. The electrical conductor system shall be provided and installed by the bridge crane manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to erection and installation of equipment specified in this Section, the Contractor shall verify dimensions on the Drawings with field conditions at the start of the work and check continuously during construction. Assemblies and components specified in this section shall be installed in strict conformance with the manufacturer's instructions and recommendations.

B. The Contractor shall furnish oil, grease and lubricants required for initial operation. The grades of oil, grease, and lubricants shall be as recommended by the manufacturer.

3.02 FIELD TESTS

A. After installation, equipment described under this Section shall be inspected by the factory representative for proper alignment, quiet operation, proper connection, and satisfactory performance. After inspection by the factory representative, the system shall be given a full load operating testIn addition, hoisting, traveling, and safety features shall also be tested.

B. Field tests shall be performed in the presence of the Engineer. The Contractor shall produce a report of the test in a format to be reviewed and approved by the Engineer.

C. The Contractor shall furnish the labor and materials required for such tests and shall, at its own expense, correct defects in the fabrication, erection and operation of the system.

D. All structural welds and bolted connections shall be tested in accordance with Division 5 requirements.

3.03 MANUFACTURER'S SERVICES

A. Furnish the services of factory-trained service technician, certified by the manufacturer to service the type of equipment specified in accordance with the requirements of the General Conditions of the Contract Documents and as specified herein.

B. The service technician must have a minimum of five years of experience, all within the last seven years, servicing the type and size of equipment specified.

C. Service technician must be present on site for all items listed below. Work-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

D. Assistance during equipment installation to include observation, guidance, instruction of Contractor's assembly team, erection, installation procedures, inspection and checking of installation to furnish written approval of installation

1. 1 work-day per crane.

E. Assistance during functional and performance testing and startup demonstration, and product acceptance by the Owner.

1. 1 work-day per crane.

F. Training of Owner's personnel in the operation and maintenance of equipment as required. Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom session.

1. ½ work-day.

G. For the purposes of this paragraph, a work day is defined as an eight hour period at the Project site, excluding travel time. The Engineer may request that a work day be furnished in a maximum of two trips.

H. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

END OF SECTION 14600

SECTION 15050
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The work described in this Section and/or indicated on the Drawings shall include the furnishing of all materials, equipment, appurtenances, accessories, connections, labor, etc., required and/or necessary to completely install, clean, inspect, adjust, test, balance and leave in safe and proper operating condition all mechanical systems.

B. Prior to the ordering or purchase of any equipment or materials or the layout or installation of any work, the Contractor shall visit and examine the site and shall examine and understand the work shown on the Drawings and described in these Specifications. If any work involves existing equipment, ductwork, piping, buildings, etc., the Contractor shall first verify model numbers, electrical characteristics, sizes, dimensions, etc., to be compatible with the work shown on the Drawings.

C. Throughout the course of the Project, the Contractor shall schedule and coordinate work with the Engineer and other trades to optimize space utilization and avoid conflict or interference with the work of other trades, structural elements, doors, windows, lights, conduit and other equipment or systems.

D. Unless otherwise shown on the Electrical Drawings, the mechanical work shall include the following items. These items shall conform with the requirements of Division 16.

1. All motors, motor starters, disconnect switches, relays and other controls and control wiring necessary for the proper operation of all mechanical equipment shall be furnished and installed under Division 15 and as specified under Division 16. Power wiring to mechanical equipment and 120-volt source for control power shall be provided as a part of the electrical work.

2. All controls and control wiring for HVAC equipment shall be provided and installed under Division 15. Where control power is not available in the vicinity of mechanical equipment, a transformer shall be furnished and installed to convert power voltage to control voltage. The transformer may be an integral part of the starter.

3. Starters complete with "hand-off-automatic" switches, with running indication lights in an approved enclosure, shall be furnished and installed for mechanical equipment automatically started and stopped, or otherwise controlled by thermostats, timers, or other devices under Division 15 and as specified under Division 16. Starters for all manually controlled equipment shall include start-stop pushbuttons with running indication lights in an approved enclosure.

4. Starters shall be of the reduced voltage part winding type for all equipment with motors 50 HP and larger as shown on the Drawings or specified in Division 16.

5. Disconnect switches shall be provided for mechanical equipment in accordance with the National Electrical Code. Coordinate type (fused or not), fuse ratings, enclosure type and installation with equipment nameplate, NEC, NEMA and Sections 16050 and 16440 requirements.

E. All electrical items provided under Division 15 of the Specifications shall be provided in accordance with applicable sections of Division 16. Enclosures shall be the same NEMA type as specified in Division 16 or on the Electrical Drawings.

F. The Contractor shall be responsible for the satisfactory and complete execution of all work included. The Contractor shall produce complete finished operating systems and provide all incidental items required as part of the work, regardless of whether such item is particularly specified or indicated.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

B. Drawings and Specifications

1. The Drawings are diagrammatic and, unless specifically dimensioned, are intended to show only the general arrangement of equipment and accessories, and the general routing of piping, ductwork, etc. The Drawings do not specifically show every fitting, offset, contour, etc., required to accomplish the intended work or to avoid every interference that may be encountered. It shall be the responsibility of the Contractor to arrange all work to fit within the allowed space without modifying any building structure or property, and to make readily accessible all equipment and accessories requiring servicing or maintenance.
2. Should any changes be deemed necessary by the Contractor in items shown on the Contract Drawings, the Contractor shall submit shop drawings, descriptions, and the reason for the proposed changes to the Engineer for approval.
3. Exceptions and inconsistencies in Drawings and Specifications shall be brought to the Engineer's attention before Bids are submitted.
4. Titles of Sections and Articles in these Specifications are introduced merely for convenience and are not to be construed as complete segregation of tabulation of the various units of material and/or work.

C. Operation and Maintenance Instructions: Operation and maintenance instructions shall be provided in accordance with the requirements of the General Conditions of the Contract Documents. The Contractor shall instruct the City's personnel during the adjustment and testing period. The Contractor shall also, in the presence of the Engineer, demonstrate the complete operation of each and every piece of apparatus.

D. Permits and Inspections

1. Obtain and pay for, as part of the mechanical work, all permits, fees, licenses, taxes, assessments, etc. necessary for performing the work outlined in the Contract Documents.
2. All applicable certificates of inspection shall be delivered to the Owner at the completion of the work.

1.03 QUALITY ASSURANCE

A. The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these Specifications.

B. Codes and Standards

1. All mechanical work shall be performed in accordance with all applicable codes, ordinances, rules and regulations of local, state, federal or other authorities having jurisdiction. As a minimum, this shall include:
   a. International Building Code, 2006 Edition
   b. International Fire Code, 2006 Edition
   c. International Plumbing Code, 2006 Edition
   d. International Mechanical Code, 2006 Edition
   e. International Fuel Gas Code, 2006 Edition
   f. National Electrical Code, 2011 Edition
   g. International Energy Conservation Code, 2009 Edition
   h. Rules and Regulations of the Safety Fire Commissioner for the State Minimum Fire Safety Standards (NFPA)
   i. Unless otherwise specified on the Drawings, the latest edition of all codes, including state and local amendments as adopted by the Board of Community Affairs or ordinances, shall be followed. Where code or other requirements exceed the provisions shown on the Contract Documents, the Contractor shall notify the Engineer. Where provisions of the Contract Documents exceed code or other requirements, the Work shall be performed in accordance with the Contract Documents.
2. All equipment, products and materials used in mechanical work shall be listed by Underwriter's Laboratories, ARI or AMCA as appropriate.
3. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Engineer.

C. Allowable Tolerances: Equipment shall be readily adaptable for installation and operation in the structures shown on the Drawings. No responsibility for alteration of a planned structure to accommodate other types of equipment will be assumed by the City. Equipment, which requires alteration of the structures, will be considered only if the Contractor assumes all responsibility for making and coordinating all necessary alterations. All such alterations shall be made at the Contractor's expense.

1.04 QUALITY STANDARDS

A. All materials shall be furnished by manufacturers fully experienced, reputable and qualified in the manufacture of the particular material to be furnished. All material shall be designed, constructed and installed in accordance with standard practices and methods and shall comply with these Specifications as applicable.

B. The manufacturer shall provide written certification to the Engineer that all equipment furnished complies with all applicable requirements of these Specifications.

1.05 TRANSPORTATION AND DELIVERY

A. As part of the mechanical work, the Contractor shall provide and pay for all transportation, delivery and storage required for all equipment and materials.

B. The Contractor shall closely coordinate the ordering and delivery of all mechanical equipment with other trades to assure that equipment will be delivered in time to be installed in the building without requiring special or temporary access or building modifications. Certain equipment may have to be installed prior to the erection of the building walls or roofs.

1.06 STORAGE AND PROTECTION

A. Equipment and materials shall be properly stored to protect against vandalism, theft, the elements and other harm or damage. Any equipment or materials received in a damaged condition, or damaged after receipt, shall not be installed. Only new undamaged equipment in first-class operating condition shall be installed.

B. Provide protection covers, skids, plugs or caps to protect equipment and materials stored or otherwise exposed during construction.

1.07 WARRANTY

A. All mechanical work described in the Contract Documents shall be warranted in accordance with the General Conditions of the Contract Documents.

B. This warranty shall apply to all equipment, materials and workmanship.

C. During the warranty period, all defects in mechanical systems shall be corrected in an acceptable manner, consistent with the quality of materials and workmanship of original construction, at no expense to the City.

PART 2 - PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be new, of the best grade and quality and of current production, unless specified otherwise. Equipment not specified in the Contract Documents shall be suitable for the intended use and shall be subject to approval by the Engineer.
2. All equipment, products and materials shall be free of defects and shall be constructed to operate in a safe manner without excessive noise, vibration, leakage or wear.
3. Electric motors shall be as specified in Section 16150, Electric Motors, unless otherwise specified.

B. Piping: See appropriate sections of Division 15 for Specifications on various piping systems.

C. Valves: See appropriate sections of Division 15 for Specifications for general stipulations on valve installation.

D. Unions

1. Provide and install unions between each item of equipment and the valve controlling and/or the various piping connections to it.
   a. Steel Pipe: Unions 2-1/2-inches and smaller shall have ground joints. Unions 3-inches and larger shall have flanged unions.
   b. PVC Pipe: Unions 2-inches and smaller shall be threaded and have Buna O-rings. Unions 2-1/2-inches and larger shall be flanged.

E. Equipment Bases: Each piece of equipment, which is motor driven shall be furnished with an approved base, which shall be in addition to the foundation. Each base shall be furnished integral with the equipment or apparatus, or shall be furnished as a separate item, designed to accommodate the equipment or apparatus. Submit shop drawings for all foundations and supports for review.

F. Dielectric Isolation

1. Wherever dissimilar metals are used in piping systems, this connection shall be made with dielectric isolators. The dielectric isolators shall be so designed that non-ferrous piping materials shall be isolated by the use of Teflon or nylon isolating materials made up in the form of screwed type unions or insulating gaskets and bolt sleeves and washers for standard flanged connection. All dielectric isolators shall be selected for the pressure and contents of the system involved.
2. Dielectric isolators shall be Watts, Epco, Crane or Maloney.

G. Anchor Bolts

1. All anchor bolts shall be ANSI type 316 stainless steel and must conform to requirements of Section 01600 and the material articles in the appropriate Sections in which they are used.
2. All anchor bolts are to be supplied by the manufacturer or fabricator of the specific material or equipment to be installed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All equipment, materials, accessories, etc. used as part of the mechanical work shall be installed according to the manufacturer's recommendations and in accordance with the best practice and standards for the work.
2. All work shall be performed by competent personnel satisfactory to the Engineer. All work requiring particular skill shall be performed by persons that have had special training and past experience in that line of work.

B. Equipment Support

1. Major equipment supports (concrete foundations, framed structural openings, etc.) shall be furnished and installed under other Divisions of the Contract Documents as shown on the Drawings. The mechanical work shall include, however, the furnishing and installation of

all miscellaneous equipment supports, housekeeping pads, structural members, rods, clamps and hangers required to provide adequate support of all mechanical equipment.

2. Unless otherwise shown on the Drawings, all mechanical equipment, piping and accessories shall be installed level, square and plumb.

C. Pipe and Ductwork Penetrations

1. Sleeves or wall pipes shall be installed in all masonry or concrete walls, floors, roofs, etc. for pipe and ductwork penetrations. See Section 15060 for pipe sleeve material requirements. Sleeves for ductwork shall be 20 gauge galvanized steel. Sleeves shall be sized to provide a minimum of ¼-inch clearance between the sleeve and pipe or duct. For insulated pipes or ducts, the clearance shall be ¼-inch between the sleeve and the insulation.

2. As far as possible, all pipe and ductwork penetrations shall be made at the time of masonry or concrete construction. Where drilling is required, only core drills shall be used. Star drills shall not be used.

D. Welding

1. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process.

2. All welding operations shall conform to the latest recommendations of the American Welding Society or to the applicable provisions of the Code for Pressure Piping. The Contractor shall pay for all electrical energy and/or gas used in welding.

E. Cutting and Patching: Where cutting or patching becomes necessary to permit the installation of any work or should it become necessary to repair any defects that may appear in patching, the Contractor shall make the necessary repair at no cost to the Owner.

F. Large Apparatus and Equipment: All large apparatus and equipment which is specified or shown to be furnished or installed under this Contract, and which may be too large to be moved into its final position through the normal building openings planned, shall be placed by the Contractor in its approximate final position before any obstructing structure is installed. All apparatus shall be cribbed up from the floor and cared for as specified under Paragraph 1.06 or as directed by the Engineer.

G. Cross Connection and Interconnections

1. No plumbing fixture, device or piping shall be installed which will provide a cross connection or interconnection between a distributing supply for drinking or domestic purposes and a polluted supply, such as drainage system or a soil or waste pipe which will permit or make possible the backflow of sewage, polluted water or waste into the water supply system.

2. The Contractor shall verify location of all existing utilities and make all connections to existing facilities as required.

H. Thermal Expansion of Piping

1. The Contractor shall furnish and install all devices required to permit the expansion and contraction of all work installed by the Contractor, particularly in water supply and

circulating systems. In the main water and circulating lines, Contractor shall employ expansion joints where required or directed by the Engineer. Swing joints, turns, expansion loops or long offsets shall be provided wherever shown on the Drawings or wherever necessary to allow for the expansion of piping within the building. Broken pipes or fittings broken due to rigid connections must be removed and replaced at the Contractor's expense.

2. Anchor all lines having expansion joints so that expansion and contraction effect is equally distributed. Verify exact locations of anchors with the Engineer prior to making installation. The lines having expansion joints shall be accurately guided on both sides of each joint. These guides shall consist of saddles and "U" clamps properly arranged and supported. Submit complete details for approval.

3. In installing expansion members exercise care to preserve proper pitch on lines. Furnish and install all special fittings, connectors, etc., as required.

3.02 SURFACE PREPARATION, SHOP AND FIELD PAINTING

A. Unless otherwise specified herein or shown on the Drawings, general painting of mechanical equipment shall be in accordance with Section 09900, Painting.

B. Touch-up painting of mechanical equipment shall be part of the mechanical work. All equipment and materials that are painted or coated by the manufacturer shall be touched-up prior to completion to conceal any and all scratches or other finish irregularities and to maintain the integrity of the paint or coating. All painting and coating shall match the original and shall conform to the requirements detailed in other sections of these specifications.

C. All roof-mounted equipment shall be painted with an exterior paint of a type and color as specified in Section 09900, Painting. The painting shall not impair the performance of the equipment in any manner.

3.03 INSPECTION AND TESTING

A. The mechanical work shall include all materials and labor required to properly test and balance all mechanical systems as required by codes and as described herein.

B. Concealed, underground and insulated piping shall be tested in place before concealing, burying or covering. Tests shall be conducted in the presence of the Engineer or designated representative. Equipment, materials and instruments required for tests shall be furnished without incurring additions to the Contract. The Contractor shall schedule all required tests and inspections with a minimum of 72 hours prior notice to the Engineer.

C. Unless otherwise specified herein, all mechanical piping shall be tested as required by Code to 1-1/2 times the rated system pressure or 100 psig, whichever is greater. Care shall be taken to isolate all equipment not suitable for this test pressure by installing pipe caps or blank flanges at the equipment connections. All valves and fittings shall be tested under pressure.

D. Unless more stringent requirements are specified herein, the following procedures shall be used for pressure testing building mechanical piping gravity-drained piping systems. Soil, waste and vent piping shall be tested with water before installing fixtures. Water test shall be applied to the system either in its entirety or in sections. If the test is applied to the entire system, all openings in the piping shall be closed except to highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening except the highest

opening of the section under test shall be plugged and each section shall be filled with water and tested with at least a 10 foot head of water. Each joint or pipe in the building except the uppermost 10 feet of the system shall be submitted to a test with at least a 10 foot head of water. The water shall be kept in the system, or in the portion under test, for at least 1 hour before the inspection starts; no substantial drop in the water level will be acceptable.

E. The services of an independent testing and balancing agency shall be used to balance the air and water distribution systems.

3.04 CLEANING

A. At all times, the premises shall be kept reasonably clean and free of undue amounts of waste, trash and debris by periodic cleaning and removal. After completion, all foreign material, trash and other debris shall be removed from the site.

B. After all equipment has been installed, and prior to testing and balancing, all equipment, piping, ductwork, etc. shall be thoroughly cleaned both inside and out.

C. All air moving equipment operated during construction shall have filters in place and changed regularly so as to be clean.

D. After testing and balancing and just prior to Engineer review and acceptance, all systems shall be finally cleaned and shall be left ready for use. Air filters shall be new and piping strainers shall be clean.

E. All water piping shall be cleaned and disinfected in accordance with Section 15060 of these Specifications.

END OF SECTION 15050

SECTION 15060
PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, tools, equipment, transportation, labor, supervision, and incidentals required to furnish, store, install, clean, and test, complete piping systems including all fittings, sleeves, supports, unions, and accessories, as specified herein and/or shown on the Drawings. The materials to be used for piping systems are listed by service in the Piping Schedule included on the Process Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related work specified elsewhere:

1. Section 02200 - Earthwork
2. Section 02730 – Sewers, Storm Drains and Accessories
3. Division 3 – Concrete
4. Section 05120 – Structural Steel
5. Section 05500 – Miscellaneous Metals
6. Section 09900 - Painting .
7. Section 15100 - Valves and Appurtenances.
8. Buried ductile iron pipe for gravity sewer is specified under Section 02730.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's certification.
2. Manufacturer's data.
3. Pipe support calculations.
4. Piping layouts, schedules, shop fabrication drawings, specifications, catalog cuts and other data necessary to show conformance of the complete piping systems to these Specifications.

5. Drawings showing dimensions, fittings, locations of equipment, valves, all piping supports, anchors, expansion joints, mechanical couplings and all other piping appurtenances, joint locations and details, types and locations of supports, coordination with all other work and existing conditions, and all other pertinent technical specifications for the piping systems to be furnished.

6. Shop fabrication drawings shall show alloys, diameters, pipe wall thicknesses, flanges and other joint preparation details, dimensions, fittings and other appurtenances to be supplied.

7. Welding procedures and qualification reports in accordance with Section 05120.

B. Prior to its incorporation into the work, the Contractor shall submit to the Engineer written evidence that the pipe furnished under this Specification is in conformance with the material and mechanical requirements specified herein. Certified copies of independent laboratory test results or mill test results from the pipe supplier may be considered evidence of compliance provided such tests are performed in accordance with the appropriate ASTM testing standards by experienced, competent personnel. In case of doubt as to the accuracy or adequacy of mill tests, the Engineer may require that the Contractor furnish test results from an independent testing laboratory on samples of pipe materials.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. American National Standards Institute (ANSI).

2. American Society for Testing Materials (ASTM).

3. American Water Works Association (AWWA)

1.04 QUALITY STANDARDS

A. All such work shall be done by competent workmen in a thorough workmanlike manner according to the best practice and in compliance with all codes and applicable regulations, with proper provisions for uncoupling, draining, expansion and contraction.

B. See applicable sections of Part 2 - Products for Manufacturer quality standards.

1.05 STORAGE AND PROTECTION

A. All piping and tubing and accessories shall be stored above ground fully supported so as not to bend or deflect excessively under their own weight. Piping shall be stored with slope so as to be free draining.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: No broken, cracked, deformed, imperfectly coated or otherwise damaged or defective pipe or fittings shall be used. All such materials shall be removed from the site.

B. Stainless Steel Pipe and Fittings – 3-inch and Smaller:

1. Material: Unless otherwise indicated, stainless steel pipe shall be in accordance with ASTM A 312 - Seamless and Welded Austenitic Stainless Steel Pipe, Type 316, seamless, Schedule 40, with welded fittings for sizes up to and including 3inches and welded fittings or flanged fittings for sizes larger than 3-inches.

2. Joints : Where indicated stainless steel pipes 3- inches and smaller shall have welded joints with socket-welding fittings, butt-welding fittings, or socket welding flanges. Stainless steel flanges shall have stainless steel bolts and nuts. Where indicated, stainless steel pipe shall have grooved ends for shouldered couplings, except that no pipe with less than Schedule 40 wall thickness shall be grooved. Where indicated, stainless steel pipe shall have plain ends for sleeve-type couplings.

3. Fittings:
   a. Socket-Welding Fittings: 3,000 lbs. type 316 forged stainless steel fittings conforming to ASTM A 82 / A 182M and ASME B 16.11.
   b. Butt-Welding Fittings: Wrought stainless steel butt-welding fittings conforming to ASTM A 403 - Wrought Austenitic Stainless Steel Piping Fittings, and ASME B 16.9 - Factory-Made Wrought Steel Butt-Welding Fittings, Type 316.
   c. Grooved Fittings: Wrought stainless steel grooved fittings conforming to ASTM A 403 and ASME B 16.9, with grooving conforming to AWWA C606 - Grooved and Shouldered Joints, Type 316.
   d. Flanged Fittings: Type 316 stainless steel flanged fittings and flanges conforming to ASME B 16.5 - Pipe Flanges and Flanged Fittings.

C. Polyvinyl Chloride Pipe and Fittings (PVC Pressure Piping):

1. Polyvinyl Chloride Pipe less than 4 inch diameter nominal pipe size shall be of unplasticized compounds suitable for use with chemicals and sewage, as shown on the Drawings and as specified and shall bear the seal of approval to this effect from an accredited testing laboratory. Pipe shall conform to the requirements of ASTM D1784 and D1785, Schedule 80, Type 1, Grade 1, or class 12454-B. Potable water pipe 4 inch through 12 inch shall be rated for Potable Water service and meet the requirements of ANSI / AWWA.C900 class 250 psi.

2. Fittings for pipe less than 4 inch diameter nominal pipe size shall conform to the requirements of ASTM Designation D2467, Class 12454-B for socket type and ASTM Designation D2464 for threaded type. Potable water pipe fittings for pipe 4 –nch through 12 inch shall be ductile iron mechanical joint bell fittings and or ductile iron slip bell fittings for use with AWWA C900 pipe and have a pressure rating of at least 250 psi.

3. Compounds for pipe and fittings shall conform to the requirements of ASTM Designation D1784, Class 12454-B.

4. Joints shall be the solvent-welded socket, bell and spigot, or flanged type. Flanges, where shown, shall be 150-pound, and shall be of the same material as the pipe. Bell and spigot pipe shall meet the requirements for potable water pipe.

5. Bolts for use with PVC flanges shall be as follows:

With Flat Ring Gaskets	Carbon steel, ASTM A307, Grade B square head bolts and ASTM A563, Grade A heavy hex head nuts
With Full Face Gaskets or in Submerged, Corrosive, or Buried Service	Type 316 stainless steel, ASTM A193, Grade B8M hex head bolts and ASTM A194, Grade 8M hex head nuts

   a. Gaskets shall be EPDM or Viton, full-faced, and 1/8 – inch thick, minimum.

   b. All socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacturer and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Provide adequate ventilation when working with pipe joint solvent cement.

   c. Provide magnetic tracer tape for all buried PVC piping.

D. Chlorinated Polyvinyl Chloride Pipe

1. CPVC pipe shall be in accordance with ASTM F 441 - Chlorinated Poly Vinyl Chloride (CPVC), Plastic Pipe, Schedules 40, and 80, from all new compounds, meeting the requirements of Class 23447 per ASTM D 1784 - Rigid Poly Vinyl Chloride Compounds and Chlorinated Poly Vinyl Chloride Compounds. CPVC pipes shall be Schedule 80 pipe unless otherwise indicated. All materials in shall be compatible with raw sewage and various forms of hydrogen sulfide present in raw sewage.

2. Pipe joints shall be solvent-welded with solvent cement in accordance with ASTM F 493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings, and with primer in accordance with ASTM F 656 - Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings. Flanged joints shall be made with solvent-welded CPVC flanges, drilled to ASME B 16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated. All materials in shall be compatible with raw sewage and various forms of hydrogen sulfide present in raw sewage.

3. Solvent-Welded Fittings: Solvent-welded fittings shall be Schedule 80 CPVC fittings in accordance with ASTM F 439 - Socket-Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 80. All materials in shall be compatible with raw sewage and various forms of hydrogen sulfide present in raw sewage.

4. Flanged Fittings: Flanged fittings shall be fabricated Schedule 80 CPVC fittings with 150 lb. flanges to ASME B 16.5. Gaskets shall be ANSI 150 lb. full face, 1/8-inch thick Neoprene for water or wastewater service. Gasket material for chemicals shall be suitable for the chemical service.

5. Bolts for use with CPVC flanges shall be as specified for PVC flanges in paragraph 2.01.C.

E. Ductile Iron Pipe:

1. Unless otherwise specified elsewhere, ductile iron pipe shall have a minimum wall thickness in accordance with Pressure Class 350, except for sizes 14 inches and larger, which shall

have a minimum wall thickness in accordance with Pressure Class 250. All ductile iron pipe supplied shall conform to the requirements of ANSI/AWWA Specifications C150/A21.50-81 and C151/A21.51-1981.

2. Fittings in pipe lines shall conform to the requirements of ANSI/AWWA C110/A21.10-82, Pressure Class 350 for 12 inch and smaller and Pressure Class 250 for 14 inch and larger sizes.

3. Exposed ductile iron piping shall be coated/painted externally per the requirements of Section 09900 – Painting and lined internally as specified on the Pipe Schedule.

4. Exposed joints shall be flanged or restrained mechanical joints unless otherwise shown on the Drawings. Buried joints shall be restrained, push-on or mechanical joints as specified on the drawings or schedule and shall conform to the following requirements:

Flanged	ANSI/AWWA C110 & ANSI B16.1, faced and drilled 125-pound ANSI Standard
Mechanical Joint	ANSI/AWWA C110, ANSI/AWWA C111 and ANSI/AWWA C151
Grooved Joint	ANSI AWWA C606 and ANSI/AWWA C151
Push-On	ANSI/AWWA C110, ANSI/AWWA C111 and ANSI/AWWA C151, equal to American Cast Iron Pipe Company, or U.S. Pipe and Foundry Tyton joint

5. Restraining of joints shall be as recommended in the Ductile Iron Pipe Research Association (DIPRA) Handbook of Cast Iron Pipe.

6. Mechanical joints with retainer glands are not acceptable.

7. Flanges shall be ductile iron, threaded, rated for 250 psi working pressure, and conform to ANSI A21.15/AWWA C115 and ANSI 125-pound drilling.

8. Bolts, studs, washers and nuts for flanges and mechanical joints shall be Type 316 stainless steel conforming to the requirements of ASTM A193/320 Grade B8 and ASTM A194 and shall meet the requirements of Section 05500 – Miscellaneous Metals.

9. Gaskets for mechanical or push-on joints shall be rubber, conforming to ANSI A21.11, AWWA C111. Gaskets for flanged joints shall be 1/8-inch thick, cloth-inserted rubber conforming to applicable parts of ANSI B16.21 and AWWA C207. Gasket material shall be free from corrosive alkali or acid ingredients and suitable for use in sewage or potable water lines. Gaskets shall be full-face type for 125-pound FF flanges. Gaskets for grooved joints shall be molded conforming to the requirements of ANSI/AWWA C606.

10. Interior Lining: Ductile iron pipe and fittings shall be lined with ceramic epoxy when specified in the Pipe Schedule. Ceramic epoxy lining shall be as specified below:
    a. All ductile iron pipe and fittings shall be delivered to the application facility without asphalt, cement lining or any other lining on the interior surface.
    b. Linings shall cover all exposed surfaces of pipe and fittings subject to contact with sewer liquid or gas. The lining of the pipe barrel shall extend from spigot end through the socket to the edge of the gasket sealing area or recess for pipe using push-on gaskets, and to the edge of the gasket seat for mechanical joints. The lining shall also cover the exterior of the spigot end from the end of the pipe to beyond the gasket sealing area. The lining in fittings shall cover the interior surfaces including the socket

areas as defined above. Lining shall not be used on the face of flanges. All linings shall be hermetically sealed at the ends.

c. Lining Materials: The lining material shall be amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment epoxy formulated for corrosion control with the following minimum requirements:

i) A permeability rating of 0.0 perms when measured by ASTM E 96, Procedure A. Duration of test shall be 30 days.

ii) A direct impact resistance of 125 inch-pounds with no cracking when measured by ASTM D 2794.

iii) The ability to build at least 50 mils dry in one coat.

iv) The material shall be recoatable with itself for at least seven days with no additional surface preparation when exposed to direct summer sun and a temperature of 90 degrees F.

v) The material shall contain at least 20 percent by volume of ceramic quartz pigment.

vi) A test and service history demonstrating the ability of the material to withstand the service expected.

vii) Possess a minimum solids volume content of 88 percent, + one percent.

viii) Possess a maximum drying time to allow recoating as follows: 50 degrees F - 72 hours; 75 degrees F - 18 hours; 90 degrees F - 8 hours. If recoating cannot be accomplished within seven days, a light brush blast shall be performed to improve intercoat adhesion.

ix) ASTM B-117 salt Spray (scribed panel) result equal to 0.0 undercutting after 2-years.

x) ASTM G-95 Cathodic Disbondment 1.5 volts @ 77 °F result equal to no more than 0.5 mm undercutting after 30 days.

xi) Immersion test rating using ASTM D-714-87 shall be equal to or better than the following:

a) 20% Sulphuric acid – No effect after two years

b) 140° F 25% Sodium Hydroxide – No effect after two years

c) 160° F Distilled Water - No effect after two years

d) 120° F Tap Water (scribed panel) – No undercutting after two years, no effects.

xii) The lining material shall be Protecto 401 Ceramic Epoxy or Equal

d. Application

i) Lining shall be applied by a certified firm with a successful history of applying ceramic epoxy lining to the interior of ductile iron pipes and fittings.

ii) Lined pipe and fittings shall be handled only from outside of the pipe and fittings. No forks, chains, hooks, straps, etc. shall be placed inside the pipe for lifting, positioning or laying. Pipes shall not be dropped or unloaded by rolling. Pipes shall not be allowed to strike sharp objects while swinging or being offloaded. Pipes shall be handled strictly in conformance with lining manufacturers' recommendations.

iii) Lining of pipe barrel and fittings shall be 40 mils nominal thickness; minimum lining thickness shall be 30 mils. Lining thickness for exterior of spigot and interior of socket shall be 8 to 10 mils.

iv) The lining shall be applied using a centrifugal lance applicator by applicators certified by the lining manufacturer. The workers shall be experienced and competent in the surface preparation, application and inspection of the lining to be applied. The compound shall not be applied when the substrate temperature is below 40 degrees F or in adverse atmospheric conditions which will cause detrimental blistering, pin-holing or porosity of the film.

e. All pipe and fitting linings shall be tested for pinholes in accordance with ASTM G 62, Method B and shall be holiday free.

f. All pipe linings shall be checked for thickness using a magnetic film thickness gauge.

g. Each pipe joint and fitting shall be marked with the date of application of the lining system and with the numerical sequence of application of that date.

h. Touch up repairs shall be in accordance with manufacturer's recommendation

F. Steel Pipe and Fittings

1. Steel pipe supplied shall be schedule 40 carbon steel, black, electric fusion welded or seamless conforming to the requirements of ASTM A 53, Grade B, with beveled ends. Pipe joints shall be butt-welded or flanged, as specified herein. Tees shall be ANSI B16.4 welding tees.

2. Butt-welded flanges shall be carbon steel, to match pipe wall thickness. Fittings shall be seamless conforming to ASTM A234 and ANSI B16.9. Use long radius elbow unless otherwise noted.

3. Flanges shall be 150 lb. forged steel, conforming to ASTM A181 and ANSI B16.5. Carbon steel, ASTM A 307, Grade A hex head bolts ASTM A 563, Grade A hex head nuts shall be used. Gaskets shall be 1/16-inch thick neoprene, full-face type.

G. Copper and Copper Alloy Pipe, Tubing, and Fittings

1. Copper tubing shall be seamless, and conform to, ASTM B88 (Type K and L).

2. Fittings shall be commercially pure wrought copper, socket joint, and conforming to ASTM B75 and ANSI Bl6.22.

3. The solder used shall be 95-5 wire solder conforming to ASTM B32, Grade 95 TA. Do not use cored solder.

4. Piping fabrication and installation shall conform to the requirements of Chapter V of ANSI B3 1.3.

5. Bends in soft temper tubing shall be long sweep, wherever possible. Bends shall be shaped with bending tools and shall be made without appreciable flattening, buckling, or thinning of the tube wall at any point. Tubing shall be cut square and burrs removed. Inside of fittings and outside of tubing shall be cleaned with steel wool and muriatic acid before sweating. Take care to prevent annealing of fittings and hard-drawn tubing when making connections. The qualification of brazing procedures, brazers, and brazing operators shall be in accordance with the requirements of Articles XII and XIII, Section IX, ASME Boiler and Pressure Vessel Code.

H. Cast Iron Soil Pipe and Fittings

1. Piping Internal to Building:
   a. Piping interior to buildings is specified under Specification section 15400 Plumbing.
2. Underground – Exterior to Buildings:
   a. Pipe and fittings: Coated service weight cast iron hub and spigot soil pipe, ASTM A74, ANSI A112.5.1, Federal Spec. WW-P-401e.
   b. Gasket: Neoprene rubber, CS-188.

I. Fiberglass Reinforced Plastic Pipe and Fittings

1. 2"-24" Pipe. The pipe shall be manufactured by the filament winding process using an amine cured epoxy thermosetting resin to impregnate strands of continuous glass filaments, which are wound around a mandrel at a 54-3/4 inch winding angle under controlled tension. Pipe shall be heat cured and the cure shall be confirmed using a Differential Scanning Calorimeter. Pipe shall be supplied with a matching tapered bell and a matching tapered spigot. Pipe shall have a minimum continuous steady pressure rating of 225 psig at 210° F in accordance with ASTM D2992 Procedure A. All pipe shall be 100% hydrotested at the factory before shipment at a minimum pressure of 300 psig.
2. Flanges and Fittings. All fittings shall be manufactured using the same type materials as the pipe. Fittings may be manufactured either by compression molding, spray-up/contact molding, or filament winding methods. Fittings shall be adhesive bonded matched tapered bell and spigot, threaded or grooved adapters, or flanged. Fittings shall be certified to ASTM D5685. Flanges shall have ANSI B16.5 Class 150 bolt hole patterns.
3. Adhesive shall be manufacturer's standard for the piping system specified.
4. Gaskets shall be 1/8" thick, 60-70 durometer full-face type suitable for the service shown on the drawings and as recommended in the manufacturer's standard installation procedures.
5. Acceptable Products. RED THREAD II as manufactured by NOV Fiber Glass Systems or equal.

J. High Density Polyethylene Pipe (HDPE) and Fittings

1. HDPE pipe sizes ½ inch through 64 inch shall be suitable for pressure water and sewer applications. The pipe material shall meet the requirements of ASTM D 3350 with cell classification of 345464C/E or 44557C. Pipe shall meet the requirements of AWA C901 / C906 and have a minimum continuous steady pressure rating of 200 psig at 80° F in accordance with ASTM D2737.
2. Flanges and Fittings. All fittings shall be manufactured using the same type materials and have the same pressure rating as the pipe.
   a. Butt Fusion Fittings - Fittings shall be made of either PE4710 or PE 3608, with a minimum Cell Classification as noted in 2A.01A. Butt Fusion Fittings shall meet the requirements of ASTM D3261. Molded and fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans.
   b. Electrofusion Fittings - Fittings shall be PE4710 or PE 3608, with a minimum Cell Classification as noted in 2A.01A. Electrofusion Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe unless otherwise specified

c. Flanges and Mechanical Joint Adapters (MJ Adapters) – Flanges and Mechanical Joint Adapters shall be PE4710 or PE 3608, with a minimum Cell Classification as noted in 2A.01A. Flanged and Mechanical Joint Adapters can be made to ASTM D 3261 or if machined, must meet the requirements of ASTM F 2206. Flanges shall have ANSI B16.5 Class 150 bolt hole patterns.

3. The pipe shall be marked in accordance with the standards to which it is manufactured.

4. Color identification by the use of stripes or colored exterior pipe product shall be blue for potable water, or green for wastewater/sewage, or purple (lavender) for reclaimed water.

1. Marking tape shall be approved by the engineer and placed between 6 and 12 inches above the crown of pipe. Marking tape shall be minimum 3 inch width with minimum 1 inch tall letters. Tape shall be have a 0.35 mil (0.00035") solid aluminum foil core with a laminated repeating warning message "WARNING –(USE) PIPE BELOW" under a 3.75 mil clear film backing and have a 5 min overall thickness. Tape shall be color coded for the appropriate use as shown in the following table:

Color	Use
YELLOW	GAS
BLUE	POTABLE WATER
GREEN	SEWER
PURPLE	NON-POTABLE WATER

K. Insulating Flanges, Couplings and Unions. Materials and ratings shall be in accordance with the applicable piping system as listed by service in the Piping Schedule. Dielectric flanges and unions shall be equal to Epco Sales, Inc., of Cleveland, Ohio; Capitol Insulation Unions Insulating couplings shall be equal to Dresser STAB-39; R. H. Baker Series 216.

L. Couplings

1. Flexible couplings, flanged coupling adapters, or expansion joints shall be provided for piping systems at connections to equipment, and where shown. The Contractor may install additional flexible couplings to facilitate piping installation, provided that it submits complete details describing location, pipe supports, and hydraulic thrust protection.

2. Acceptable types of couplings for ductile iron pipe are as follows:
   a. Flexible Couplings: Equal to Dresser Style 153, with zinc-plated bolts and nuts. Thrust ties shall be provided to sustain the force developed by 1-½ times the test pressure specified.
   b. Transition Couplings: Transition couplings used to connect pipes with small differences in outside diameter shall be equal to Dresser Style 162.
   c. Flanged Adapters:
      i) Flanged coupling adapters shall be used for joining plain end cast iron or ductile iron pipe to flanged valves, pumps and fittings. Flanged adapters shall be suitable for working pressures to 150 psig.
      ii) Flanged coupling adapters in sizes 12-inches and smaller shall consist of an ASTM 126, Class B cast iron flanged body drilled to mate with a 125 pound cast iron flange per ANSI B16.1, a cast iron follower ring, a rubber-compound, wedge section gasket, a sufficient number of track head and electroplated steel bolts to properly compress the gasket.

iii) Flanged coupling adapters in sizes 12-inches and larger shall consist of a high strength steel, flanged body drilled to mate with a 125 pound cast iron flange per ANSI B16.1, a high strength steel follower ring, a rubber-compound, wedge section gasket, a sufficient number of track head and electroplated steel bolts to properly compress the gasket.

iv) Rubber gasket shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil and grease.

d. Grooved Couplings

i) Couplings shall conform to the requirements of ANSI/AWWA C606 - Grooved and Shouldered Joints. Gaskets shall be compatible with the piping service and fluid utilized, in accordance with the coupling manufacturer's recommendations. The wall thickness of grooved piping shall conform to the coupling manufacturer's recommendations to suit the highest expected pressure. To avoid stress on equipment, equipment connections with grooved couplings shall have rigid-grooved couplings or flexible type coupling with harness in sizes where rigid couplings are not available, unless thrust restraint is provided by other means. Couplings shall be bonded. The Contractor shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation. To assure uniform and compatible piping components, all grooved fittings, couplings, and valves shall be from the same manufacturer.

ii) Grooved couplings for Ductile Iron pipe shall be equal to Victaulic Style 31.

3. Acceptable types of couplings for steel pipe are as follows:
   a. Flexible Couplings: Equal to Dresser Style 38. Thrust ties shall be as specified above for ductile iron pipe couplings.
   b. Transition Couplings: Equal to Dresser Style 162.
   c. Flanged Coupling Adapters: Equal to Dresser Style 128. Thrust restraint shall be as specified above for ductile iron flanged coupling adapters.

4. Flexible Connectors (Bellows Type): Elastomeric bellow type flexible connectors shall be of the double arched type and shall be rated for a working pressure of 150 psig and maximum operating temperature of 150 °F. Connectors shall be flanged and shall be provided with thrust restraint system to limit elongation and compression as required. Bellows type flexible connectors shall be equal to General Rubber Corporation, or PROCO Products Inc., or FLEXICRAFT Industries.

5. All fittings and connections for tubing shall be equal to Swagelok.

M. Expansion Joints

1. Expansion joints shall be designed in accordance with Expansion Joint Manufacturer's Association (EJMA) standards for pressure, temperature and service as specified.

2. Expansion joints shall be multi-ply bellows type designed for temperatures up to 300 °F and pressures up to 100 psig. Bellows shall be constructed of 316 L stainless steel. Unless otherwise specified, end connections shall be 316 L SS flanges.

3. Expansion joints rated travel requirements (axial compression and extension) shall be as indicated on the Drawings.

4. The contractor shall submit detailed calculations and manufacturer's Shop Drawings of all proposed expansion joints, piping layouts, and anchors and guides, including information on

expansion joint material, material thickness, temperature and pressure ratings, travel ratings and axial spring rates.

5. Expansion joints shall be equal to Hyspan Precision Products Inc., Or Flexonics, Inc. Or FLEXICRAFT Industries.

N. Pipe Hangers and Supports

1. General:
   a. The Contractor shall be responsible for the proper design, fabrication, location, and installation of all pipe supports in accordance with the specified requirements. Shop drawing submittals shall be in accordance with the requirements of the General Conditions of the Contract Documents.
   b. The Contractor shall review pipe support details and locations as proposed in the drawings and shall submit calculations justifying the details and locations of supports to be installed. Calculations shall be prepared and stamped by a professional engineer registered in the state of Georgia.
   c. The Contractor shall be responsible for adequacy and appropriateness of pipe supports systems. Submittals of calculations and review by the engineer shall in no way relieve the contractor of the sole responsibility for design of pipe supports.
   d. All pipe supports and component parts shall conform to the latest requirements of the Code for Pressure Piping ASME/ANSI B31.1 and Manufactures Standardization Society (MSS) Standard Practice SP-58, SP-69, SP-89 and SP-90 except as supplemented or modified by the requirements of this specification.
   e. Pipe support design shall conform to the requirements of the latest edition of the AISC Manual of Steel Construction for miscellaneous and supplementary steel. Tube steels shall be ASTM A500 Grade B, structural shapes A36, plates A-572 or equal. Stainless steel structural members shall conform to ASTM requirement Type 316L.
   f. The Contractor shall be responsible for coordinating all pipe support designs for all trades to ensure compliance with all of the requirements of this specification.
   g. The Contractor shall design and provide all temporary pipe supports required during installation and testing.
   h. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports and hangers to be employed. Special support and hanger details are shown to cover typical locations where standard catalog supports may be inapplicable.
   i. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing supports for the piping shown on the Drawings.
   j. All submerged and intermittently submerged piping supports, guides, and fasteners in pump station wet wells and other corrosive environments shall be Type 316 stainless steel unless otherwise shown. Concrete anchors and anchor bolts shall also be Type 316 stainless steel.
   k. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment.
   l. All commercial pipe supports and hangers shall have a minimum safety factor of 5.

2. Building Piping:
   a. Horizontal piping shall be supported with adjustable wall brackets swivel-ring, split-ring, or Clevis type hangers as shown. Furnish galvanized protection shield and oversized hangers under all insulated piping. Pipe hangers for copper piping shall be copper plated and plastic coated to prevent galvanic corrosion. No metal portion of a support or hanger shall contact pipe directly.
   b. Stacked vertical and/or horizontal runs of piping along walls shall be supported by a fiberglass framing system attached with Type 316 stainless steel anchors or concrete inserts as applicable, equal to Unistrut, B-Line or equal within the framing channel limitations. No pipe shall be supported from the pipe above or below it.
   c. Pedestal pipe supports shall be adjustable, with stanchion, saddle, and anchoring flange as shown. Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation. Pads shall be equal to Mason Industries, Inc., Korfund Korpad.
   d. Horizontal piping hanger support rods shall attach to steel beams with C-clamps or beam clamps; to concrete with inserts, brackets or flanges fastened with flush shells; to wood not less than 2-½ inches thick with lag screws and angle clips.
   e. Piping supports for vertical piping passing through floor sleeves shall be galvanized steel riser clamps.
   f. All hangers, rods, clamps, protective shields, metal framing support components, and hanger accessories shall be hot dip galvanized.
   g. Horizontal pipe support or hanger spacing and hanger rod sizing shall be as shown on the schedule herein.
   h. The load rating for universal concrete inserts shall not be less than that of the hanger rods they support.
   i. When supporting ductile iron pipe, locate hanger rods at all non-rigid joints and at each change of direction.
   j. Vertical sway bracing shall be provided where shown, or on 10-foot maximum centers.
   k. All piping shall be supported in a manner, which will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown.
3. Spacing of Hangers. Pipe support spacing requirements shall be as recommended by the pipe manufacturer, but in no case shall the spacing of hangers exceed the following:

MAXIMUM UNSUPPORTED PIPE SPAN (FEET)

Nominal Pipe Size-Inches	Cast or Ductile Iron	Steel	PVC		Copper
			Schedule 40	Schedule 80	
1/2	-	5	3.0	3.5	5
3/4	-	6	3.0	3.5	5
1	-	7	3.33	3.8	6
1-½	-	9	3.5	4.0	8
2	-	10	3.5	4.33	9
2-½	-	11	4.0	4.75	10
3	-	12	4.25	5.0	10
3-½	-	13	4.25	5.0	10
4	8	14	4.5	5.25	12
6	10	17	4.8	6.0	
8	10	19	5.0	12	
10	10	22	5.5	12	
12	12	23			
14	12	25			
16	12	27			
18	14	28			
20	14	30			
24	14	32			
30 and larger	14	32			

O. Slab, Floor, Wall, and Roof Penetrations and Closures

1. All piping penetrations of slabs, floors, walls, and roofs shall be ductile iron wall pipes with integrally cast seep rings, unless otherwise noted on the Drawings. It shall be the Contractor's responsibility to verify the size and location of all building and structure penetrations prior to pouring concrete.
   a. Ductile Iron Wall Pipes:
      i) Provide ductile iron wall pipes where ductile iron piping passes through concrete walls, floors, slabs and roofs, which are to be watertight and where shown on the Drawings. Wall pipe end connections shall be as shown on the Drawings and as specified herein. Wall pipes shall be of a thickness equal to or greater than the remainder of the piping in the line and shall comply with the requirements for fittings in the applicable Specifications. All wall pipes shall be provided with seep rings. Seep rings shall be of ductile iron and cast integral with the wall pipe.
      ii) Flanges set flush with the face of concrete shall be tapped for stud bolts.
      iii) Coat outside wall of pipes as specified in Section 09900, Painting. Support wall pipes by formwork to prevent contact with reinforcing steel.
   b. Pipe Sleeves:
      i) Piping passing through concrete or masonry shall be installed through galvanized steel pipe sleeves where shown on the Drawings. Holes drilled with a suitable rotary drill will be considered in lieu of sleeves in existing walls.

ii) All sleeves in exterior or water-bearing walls shall have a center flange for water stoppage. The annular space between pipes and sleeves in exterior walls shall be watertight. The joint shall be caulked with rubber sealant, or sealed by a modular mechanical unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. The interconnected rubber links shall be assembled with zinc phosphate-plated steel bolts and nuts and steel pressure plates under each bolt head and nut to prevent the nut from turning when the bolt is tightened. Tightening of the bolts shall cause the rubber sealing links to expand, resulting in a watertight seal between the pipe and wall sleeve opening. Closures shall be sized according to manufacturer's instructions for the size of pipes shown on the Drawings.

iii) Wall sleeves shall be coated with the appropriate system for the intended location as specified in Section 09900, Painting. When placing non-insulating type wall sleeves in concrete forms, support them by formwork to prevent contact with the reinforcing steel.

P. Flexibility: Unless otherwise specified, piping 2 inches in diameter and larger passing from concrete to earth or from below a structure to outside of the structure shall be provided with two pipe couplings or flexible joints. The first joint shall be within 2 feet of the face of the structure. The second joint shall be located 2 feet or one pipe diameter (whichever is greater) after the first joint. Where required for resistance to pressure, mechanical couplings shall be restrained as specified elsewhere.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All exposed piping shall be firmly anchored and supported by pipe supports or anchors as shown or required. Pipe supports shall be furnished as shown on the Drawings or in accordance with the requirements of Paragraph 2.01 L of this section. All pipe shall be carefully placed to the proper lines and grades as shown on the Drawings.

2. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings will not be permitted. Pipe shall be cut to exact measurement and shall be installed without forcing or springing.

3. Lines which slope shall have the right-of-way over lines whose elevations can be changed. Offsets, transitions, and changes in direction in pipes shall be made as required to maintain proper headroom, slope, etc.

4. Piping shall be installed in such manner and at such times as will require a minimum of cutting and repairing of building structures. In case any such cutting or repairing is necessary, it shall be done only with the permission of the Engineer. Cutting and repairing shall be performed by craftsmen of the trade which originally executed the work, and repairs shall match the original condition.

5. All changes in direction in piping systems shall be made with suitable fittings.

6. When storing and installing pipe, care shall be taken to prevent damage to the pipe coatings. All damaged coatings shall be repaired to the satisfaction of the Engineer.

7. A liberal number of unions and/or flanged joints shall be used to permit the ready removal of any section. Unions shall be installed in all piping connections to equipment, to regulating valves, and wherever necessary to facilitate the dismantling of piping and removal of valves and other items requiring maintenance. Flanges on equipment may be considered as unions.

8. Installed piping shall not interfere with the operation of or accessibility to doors and/or windows, shall not encroach on aisles, passageways and equipment, and shall not interfere with the servicing or maintenance of any equipment.

9. The interior of all piping shall be free from obstructions and protrusions. All burrs shall be removed from the inside and outside edges of all cut pipe by reaming. Cutting shall be done in such a manner so as to leave a smooth end at right angles to pipe threads. Tool marks and unnecessary pipe threads shall be avoided. Cuttings and other foreign material shall be removed from the inside of the pipe prior to installation.

10. After installation, the interior of all piping shall be cleaned as necessary to remove flux, slag, scale, rust, dirt, oil, and other foreign material. As piping is installed, open ends shall be covered or plugged as necessary to prevent the entrance of foreign matter and to maintain the required cleanliness.

11. Changes in pipe size shall be made using reducing fittings, not bushings. If centerline elevation is not specified, use eccentric reducers in horizontal piping. On liquid lines, eccentricity shall be down with top of pipe level. On vapor and gas lines, eccentricity shall be up with bottom level.

12. Indicated locations and sizes of equipment connections are approximate; exact locations and sizes of piping, valves, etc., shall conform to approved shop drawings. Connection sizes shall not be smaller than scheduled size or equipment outlet size, whichever is larger.

13. One inch vent and drain valves shall be inserted in all high and low points of all pipes.

14. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.

15. Minimum pipe cover shall be 3 feet, as measured from the pipe barrel, unless otherwise indicated on the Drawings.

B. Installation of Steel Piping

1. Pipe threads shall be concentric with the outside of the pipe and shall conform to ANSI B2.1. When threading stainless steel pipe, dies shall have 20 to 30 degree hook. Finished joints shall have no more than three threads exposed. Before assembly, pipe ends and threads shall be inspected and any defective pieces replaced. All joints shall be properly aligned before connection to prevent thread damage. Pipe dope shall be used on the male threads of all threaded connections. Teflon thread tape shall be applied two threads back from the end of the pipe of fitting to prevent shredding. Excess pipe dope shall be trimmed or cleaned off to provide adherence for paints or coatings. After joining, exposed threads in underground piping shall be given a heavy coat of bituminous paint or other suitable protective compound prior to backfilling.

2. All flanges shall be faced and drilled and shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe. Where slip-on flanges are

used, the distance from the end of the pipe to the gasket face of the flange shall not exceed "t" plus 1/4-inch, where "t" is the pipe wall thickness. Unless otherwise required, bolt holes shall straddle the vertical and horizontal axes of the pipe. Connections to equipment shall be made in such a way that no strain is placed on the equipment flanges.

3. Flexible bellows-type connectors shall be installed in their undeformed configuration, in accordance with the joint manufacturer's instructions. Control rods shall be installed to permit fully rated expansion joint compression, and to limit expansion joint extension to 1/16-inch.

4. For flanged connections between steel piping and cast or ductile iron piping or valves, steel flanges shall be flat faced and furnished with full-face gaskets, insulating bushings, and, when buried, stainless steel bolts.

5. Where steel pipe is connected to copper tubing, insulating bushings or couplings shall be used to prevent galvanic corrosion.

C. Installation of Stainless Steel Pipe, Tubing and Fittings

1. General: Stainless steel pipe shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipe shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points. Installation shall be free from defects.

2. Supports and Anchors: Piping shall be firmly supported with fabricated or commercial hangers or supports as specified herein. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences.

3. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures, and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

4. The Contractor, during handling and installation stages, shall use extreme care to avoid the contact of any ferrous materials with the stainless steel piping. All saws, drills, files, wire brushes, etc. shall be used for stainless steel piping only. Pipe storage and fabrication racks shall be non ferrous or stainless steel or rubber lined. Nylon slings or straps or alloy chains or cable shall be used for handling stainless steel piping. After installation, the contractor shall wash and rinse all foreign matter from the piping surface. If rusting of embedded iron occurs, the contractor shall pickle the affected surface with Oakite oxidizer SS or equal, scrub with stainless steel brushes and rinse clean.

5. Painting of the stainless steel pipe is not required. However, the contractor shall be responsible for supplying and installing the stainless steel piping with a consistently clean surface. Identifying spool piece marks shall be removed with paint thinner or solvents and the entire stainless steel surface shall be washed with detergent and rinsed clean.

6. After installation, the piping system shall be tested by the Contractor according to Part 3 of this Section.

7. Welding shall be in accordance with Section 05120 and the requirements below.

8. Welded Joints: All welding shall be conducted in accordance with latest editions of Section IX, ASME Boiler and Pressure Vessel Code and the American National standard Code for Pressure Piping, ANSI B31.2 and B31.3, as applicable.

9. Welding electrodes for shielded metal arc process on Type 304L and 316L stainless steel pipe shall be AWS 5.4, E 308L; Gas Tungsten Arc or Gas Metal Arc process shall be AWS 5.9, ER 308L. The direct current, reverse polarity, shielded metal arc or gas metal arc processes or direct current, straight polarity, gas tungsten-arc process shall be used for all field welding.
   a. All welders and welding operators shall be qualified at the Contractor's sole expense by an ASME-approved testing laboratory before performing any welding under this section. Qualification tests shall be in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code. Welders and welding operators shall be qualified for making groove welds in Type 304, 304L, 316 and 316L stainless steel pipe in position 6G for each welding process to be used.
   b. Pipe edges shall be prepared preferably by machine shaping or cutting with an aluminum oxide blade. Oxygen or arc cutting are acceptable only if the cut is reasonably smooth and true and all slag is removed either by chipping or grinding. Beveled ends for butt welding shall conform to ANSI B16.25. Surfaces to be welded shall be clean and free of paint, oil rust, scale, slag, or other material detrimental to welding. Prior to welding, wire brush joints to be welded with stainless steel wire brushes or stainless steel wool.
   c. No welding shall be performed if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 32 degrees F. If the ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.
   d. Each layer of deposited weld metal shall be thoroughly cleaned prior to the deposition of each additional layer of weld metal, including the final pass, with a power-driven stainless steel wire brush. Surface defects, which will affect the soundness of weld shall be chipped out or ground out.
   e. Welds shall be free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity, slag inclusions and other defects in excess of the limits prescribed in Chapter V of ANSI B31.2 and B31.3, as applicable.

D. Installation of Ductile Iron Pipe

1. When new or existing pipe is required to be cut, the pipe shall be cut in such a manner as to leave a smooth end normal to the axis of the pipe.

2. All cutting of ductile iron pipe shall be performed with a cutting saw. All burrs shall be removed from the inside and outside edges of all cut pipes. All damaged linings and coatings shall be repaired.

3. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.

4. Ends of pipe shall be in accordance with the type of joint to be made. Dress cut ends of mechanical joint pipe to remove sharp edges or projections, which may damage the rubber gasket. Dress cut ends of pipe for flexible couplings and flanged coupling adapters, as recommended by the coupling or adapter manufacturer. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.

5. Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened so that the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.

6. Mechanical, push-on and restrained joint pipe shall be joined in accordance with the manufacturer's recommendations. Provide all special tools and devices such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes shall be permitted under any circumstances.

7. Ductile iron pipe shall be assembled in accordance with ANSI/AWWA C600.

8. Mechanical Joints
   a. The surfaces with which the rubber gasket comes in contact shall be brushed thoroughly with a wire brush just prior to assembly to remove all loose rust or foreign material which may be present and to provide clean surfaces which shall be brushed with a liberal amount of soapy water or other approved lubricant just prior to slipping the gasket over the spigot end and into the bell. Lubricant shall be brushed over the gasket prior to installation to remove loose dirt and lubricate the gasket as it is forced into its retaining space.
   b. Joint bolts shall be tightened by the use of wrenches and to a tension recommended by the pipe manufacturer. When tightening bolts, the gland shall be brought up toward the pipe bell. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning. Overstressing of bolts to compensate for poor installation shall not be permitted.
   c. After installation, bolts and nuts in buried piping shall be given two heavy coats of a bituminous paint. Bolts and nuts for exposed or submerged service shall 316 SS in accordance with this specification.

9. Flanged Joints
   a. All flanges shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations, or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the finished pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe.
   b. Connections to equipment shall be made in such a way that no torque is placed on the equipment flanges. Connecting flanges must be in proper position and alignment and no external force may be used to bring them together properly.
   c. Flanged filler shall be used only where shown on the Drawings or approved by the Engineer to make up minor differences in pipe length, less than 3-inches. Joint bolts shall be increased in length by the thickness of the flange filler.

10. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conforming to AWWA C606. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

11. Installing Pipes
    a. Proper and suitable tools and appliances for safe and convenient handling and laying of pipe and fittings shall be used. Care shall be taken to prevent the pipe coating from being damaged, particularly cement and other linings on the inside of the pipes and fittings. Any damage shall be remedied as directed by the Engineer.
    b. All pipe and fittings shall be carefully examined by the Contractor for defects just before installing and no pipe or fitting shall be installed if it is defective. If any defective pipe or fitting is discovered after having been installed, it shall be removed and replaced in a satisfactory manner with a sound pipe or fitting by the Contractor at Contractor's own expense.
    c. All pipes and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they are used in the completed work. Open ends of pipe shall be kept plugged with a bulkhead during construction.
    d. All elbows, tees, brackets, crosses, and reducers in pressure piping systems shall be adequately restrained against thrust.
    e. Flexible bellows-type connectors shall be installed in their undeformed configuration, in accordance with the joint manufacturer's instructions. Control rods shall be installed to permit fully rated expansion joint compression, and to limit expansion joint extension to 1/16-inch.
    f. Wall pipe and wall sleeves shall be accurately located and securely fastened in place before concrete is poured. All wall pipe and sleeves shall have wall collars properly located to be in the center of the wall where the respective pipes are to be installed. Pipe passing through the sleeve shall extend no more than two feet beyond the structure without a pipe joint.
    g. Wall pipe and wall sleeves shall be constructed when the wall or slab is constructed. Blocking out or breaking of the wall for later installation shall not be permitted.
    h. Cutting or weakening of structural members to facilitate pipe installation shall not be permitted. All piping shall be installed in place without springing or forcing.

E. Installation of Sanitary and Waste Drain and Vent Piping

1. Set sanitary and waste drain and vent piping installed above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.
3. Make roof penetrations watertight.
4. Extend vents at least 1 foot above roof.
5. Properly slope sanitary and waste drainage piping encased in concrete.
6. Coordinate routing of drains through steel reinforcement with affected trades.
7. Make changes of direction in waste piping with combination Y and 45degree bend fittings.
8. Cleanout Fittings and Plugs:
    a. Install where shown and where required by plumbing code.
    b. T or Y branches or trap hubs shall be of the same material as the pipe in which they are installed.
9. Sanitary waste piping shall be sloped at a minimum of 1%. Vent piping shall be sloped to drain towards waste system.

F. Buried Piping System Thrust Restraint

1. General: Thrust restraint for all buried ductile iron pressure piping systems shall be accomplished by the use of restrained joints as specified hereinbefore.

2. Buried Pressure Pipelines:
   a. Thrust restraint shall be capable of restraining the buried pressure pipelines for pressures up to 1-½ times the corresponding hydrostatic test pressures listed in the Piping Schedule.
   b. Restrained joint type fittings for ductile iron pipe shall be as specified hereinbefore and on the Drawings.
   c. The Contractor shall provide restrained joints for all buried piping with test pressure higher than 20 psig.

G. Pipe Dope

1. All threaded connections shall be made up using Teflon pipe dope applied to the male threads only.

2. Virgin Teflon thread tape shall be equal to Hercules Packing Company "Herculon", 3-M Company "Scotch No.48", or Crane Packing Company "Teflon Thread tape".

3. Teflon thread paste may be used in place of tape on very large or very small joints.

H. Wall Pipes and Pipe Sleeves

1. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as specified in Section 03300, Cast-In Place Concrete and as shown. Support all pipes embedded in concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.

I. Flexible Couplings, Flanged Coupling Adapters, and Service Saddles: Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Workmen tightening bolts shall use torque-limiting wrenches.

J. Insulating Flanges, Couplings, and Unions: Install insulating flanges, couplings, or unions wherever copper and ferrous metal piping are connected, wherever submerged metallic piping is connected to unsubmerged piping, and where shown on the Drawings. Insulated joints connecting submerged piping to exposed piping shall be installed above maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged metallic piping shall be isolated from the concrete reinforcement.

K. Insulation

1. All piping and equipment shall be insulated in accordance with manufacturer's instructions including types of insulating cements, lagging adhesives, and weatherproof mastics if different from those specified.
2. All insulation shall be applied over clean, dry surfaces with all joints butted firmly together, but not until piping system has been pressure tested and any leaks corrected. Insulation shall not extend beyond flanges nor cover nameplates or code inspection stamps. Insulation shall run continuous through wall openings, ceiling openings, and pipe sleeves, unless otherwise noted.
3. Where connection is shown to existing piping, the existing insulation shall be cut back to remove the portion damaged by the piping revisions, and new insulation installed. The joint between the old and new insulation shall be finished as hereinbefore specified.
4. The Contractor shall furnish precut, sized sections of closed cell rigid insulation with vapor barrier to be inserted under piping and centered at each hanger location. Provide continuous vapor barrier at all joints between rigid insulation and pipe insulation.
5. Insulate all valve bodies, flanges, and pipe couplings. Provide removable insulation sections on all devices that require access for maintenance of equipment or removal, such as unions, strainer end plates, etc. Do not insulate flexible pipe couplings.
6. Finished appearance of all insulation shall be smooth and continuous. Provide coating of insulating cement where needed to obtain this result. Joints shall be lapped and the integrity of vapor seals maintained in strict accordance with manufacturer's instructions. Staples and screws shall not be used to secure components of systems that are vapor sealed.
7. Care shall be taken to apply the insulation and vapor barrier coating on exterior piping so that it will not be damaged when the prefabricated aluminum fitting covers are applied. The prefabricated aluminum covers shall serve as weatherproof enclosures over fittings. No screws or rivets shall be used in fastening the fitting covers, as they may puncture the vapor seal.
8. Exterior flanges and unions shall have removable prefabricated aluminum covers.

3.02 SURFACE PREPARATION AND SHOP PAINTING

A. All ferrous piping not specified to be galvanized or otherwise coated shall be cleaned and shop primed or coated in accordance with the requirements of Section 09900, Painting.

3.03 FIELD PAINTING

A. Following installation and testing, all exposed and submerged piping, including insulated piping, shall be field primed and painted in accordance with the requirements of Section 09900, Painting. Stainless steel pipe and fittings shall not be painted.

3.04 PIPING IDENTIFICATION

A. Piping Systems: Identification of piping systems shall conform to ANSI A13.1, Scheme for the Identification of Piping Systems, unless otherwise specified herein.

B. Process Piping Code: All exposed pipe shall be identified by color and labeling to show its function. Stencil-painted labels and arrows showing the direction of flow shall be installed every

20 feet or each change of direction at each valve, and on each side of wall penetrations and in valve chambers. Piping which is not painted shall be provided with 6-inch-wide color bands as specified. Color bands of an approved tape may be used on PVC, FRP and stainless steel pipe and other pipe, which does not readily accept painted finish. The color, banding and labeling shall conform to the schedule in Section 09900, Painting.

C. Process Valve Identification: After the painting of process piping is complete, the Contractor shall stencil the tag numbers of all valves numbered on the Process and Instrumentation Drawings, on the pipe adjacent to the valve for pipe 2 inches and over. Characters shall be 2 inches high minimum and shall be oriented to be visible from the valve operating position. When the valve has extended operator shaft or chain operator, the number shall be placed at both the operating position and at the valve, if practicable; this requirement does not apply if the valve is buried or in a pit. Valves in pipes under 2 inches shall have characters as large as the pipe will permit or at the Engineer's option on an adjacent surface. Characters shall be preferably white; however, if this would not provide sufficient contrast to the pipe, the Engineer may select another color. Paint used shall be of the same type and quality as that used for painting the pipe.

3.05 TESTING

A. General: Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. The Engineer will monitor the tests. Test pressures shall be as specified in the Piping Schedule.

B. Testing New Pipe Which Connects to Existing Pipe: New pipelines, which are to be connected to existing pipelines shall be tested by isolating the new Pipe.

C. Preparation and Execution

1. Buried Pressure Piping:
   a. Conduct final acceptance tests on buried pressure piping that is to be hydrostatically tested after the trench has been completely backfilled. The Contractor may, if field conditions permit, as determined by the Engineer, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The acceptance test shall not, however, be conducted until all backfilling has been completed.
   b. Buried pressure piping that is to be pneumatically tested or subjected only to an initial service leak test shall have all joints exposed for the acceptance test.
2. Exposed Pressure Piping: Conduct the tests on exposed piping after the piping has been completely installed, including all supports, hangers, and anchors, but prior to insulation.

D. Hydrostatic Leak Tests

1. Equipment: Furnish the following equipment for the hydrostatic tests:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

2. Procedure: Water shall be used as the hydrostatic test fluid unless otherwise specified. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The hydrostatic test pressure shall be continuously maintained for time duration specified in pipe schedule and for such additional time as may be necessary to conduct examinations for leakage. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.

3. Test pressure shall be measured at pump base elbow where applicable.

4. Initial Service Leak Tests:
   a. Equipment: Equipment used for initial service leak testing may be the same as that specified under Paragraphs Hydrostatic Leak Tests herein before.

      Procedure: The initial service leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. Soap bubbles shall be used to detect leaks in pneumatically-tested systems. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.

5. Test Records: Records shall be made of each piping system installation during the test. These records shall include:
   a. Date of test.
   b. Description and identification of piping tested.
   c. Test fluid.
   d. Test pressure.

6. Remarks, to include such items as:
   a. Leaks (type, location).
   b. Repairs made on leaks.

3.06 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of debris within piping sections. All piping shall be examined to assure removal of foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.07 FINAL CLEANING

A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except plant process air lines and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Engineer. Accumulated debris shall be removed through drains 2-inch and larger or by dropping spools and

valves. Immediately following drainage of flushed lines, the piping shall be air dried with compressed air.

B. Plant process air and instrument air piping shall be blown clean of loose debris with compressed air.

3.08 CORROSION PROTECTION OF PIPING SYSTEMS

A. All atmospheric exposed piping and piping components including, but not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves and fasteners shall be painted in accordance with Section 09900, Painting, as applicable to the base metal material.

B. Corrosion protection for buried piping systems, other than copper piping, is not required.

3.09 CORROSION PROTECTION FOR COPPER PIPING

A. Atmospheric Exposed Copper Pipe: Exposed copper piping shall be painted in accordance with Section 09900.

B. Exterior Coating for Buried Copper Pipe: All buried copper pipe shall be coated by hand taping with pipe tape. The pipe surface shall be solvent cleaned, SSPC-SP 1, and wire brushed, SSPC-SP 3, to remove all dirt and loose rust and mill scale, and immediately primed with the tape manufacturer's recommended primed in accordance with the manufacturer's recommendations. The tape shall be spirally applied to the pipe with a 50 percent overlap minimum after the primer has thoroughly dried. Joints shall be tape wrapped or heat shrink wrapped above grade to permit joint wrapping without contamination. Tape wrapping and heat shrink wrapping are specified under Paragraph Materials.

3.10 DISINFECTION

A. Pipelines intended to carry potable water shall be disinfected before placing in service. Disinfecting procedures shall conform to AWWA C651-86, as hereinafter modified or expanded.

B. Flushing: Before disinfecting, flush all foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc. as required to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipeline in place from the inside by brushing and sweeping, then flush the line at the highest possible velocity.

C. Disinfecting Mixture:

1. Disinfecting mixture shall be a chlorine-water solution having a free chlorine residual of 50 ppm, minimum. The disinfecting mixture shall be prepared by injecting: (1) A liquid chlorine gas-water mixture; (2) dry chlorine gas; or (3) a calcium or sodium hypochlorite and water mixture into the pipeline at a measured rate while fresh water is allowed to flow through the pipeline at a measured rate so that the combined mixture of fresh water and chlorine solution or gas is of the specified strength.
2. The liquid chlorine gas-water mixture shall be applied by means of a standard commercial solution feed chlorinating device. Dry chlorine gas shall be fed through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within

the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas or the gas itself must provide means for preventing the backflow of water into the chlorine cylinder.

3. If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a 1 percent solution (10,000 ppm chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution. The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite(1) (65-70 percent Cl)	1 lb	7.5 gal.
Sodium Hypochlorite(2) (5.25 percent Cl)	1 gal.	4.25 gal.
(1) Comparable to commercial products known as HTH, Perchloron, and Pittchlor. (2) Known as liquid laundry bleach Clorox and Purex etc.		

4. Point of Application: Inject the chlorine mixture into the pipeline to be treated at the beginning of the line through a corporation stop or suitable tap in the top of the pipeline. Clean water from the existing system or another source shall be controlled so as to flow slowly into the newly installed piping during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 50 ppm of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.

5. Retention Period:
   a. Treated water shall be retained in the pipeline long enough to destroy all nonspore-forming bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the retention period, the disinfecting mixture shall have a strength of at least 10 ppm of chlorine.
   b. Operate all valves, hydrants, and other appurtenances during disinfection to assure that the disinfecting mixture is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.
   c. Do not place concentrated quantities of commercial disinfectants in the line before it is filled with water.
   d. After chlorination, flush the water from the permanent source of supply until the water through the line is equal chemically and bacteriologically to the permanent source of supply.
   e. Disposal of Disinfecting Water: Dispose of disinfecting water in an acceptable manner that will protect the public and publicly used receiving waters from harmful or toxic concentrations of chlorine. Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.

6. Collect two samples or sets of samples from each pipe or facility at least 24 hours apart. Submit samples to a state-approved laboratory for bacteriological (coliform and non-coliform) analysis. Continue disinfecting and testing until bacteriological clearance is achieved.

3.11 PIPING SCHEDULE

A. See process drawings for Pipe Schedule.

END OF SECTION 15060

SECTION 15100
VALVES AND PIPING APPURTENANCES

PART 1 - GENERAL

1.01 SCOPE

A. The work covered by this Section includes furnishing all labor, materials, equipment and incidentals required to furnish, install and test all valves, operators and appurtenances as shown and specified and as required to make the entire facility operable except for those valves and appurtenances required to be provided in other Sections of these Specifications. Items to be provided include but shall not be limited to the following:

1. Valves.
2. Operators, floor stands and valve boxes.
3. Yard Hydrants.
4. Hose Stations.
5. Potable Water Appurtenances

B. Related Work Specified Elsewhere

1. Section 09900 - Painting.
2. Section 15050 – Basic Mechanical Materials and Methods.
3. Section 15060 - Piping and Appurtenances.
4. Division 13 – Instrumentation.
5. Division 16 - Electrical

C. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. For each type and model of valve, provide:
   a. Assembly instructions and spare parts list.
   b. Preventative/corrective maintenance instructions.
   c. Certificate of seat compatibility with specified fluid exposure.

2. For each motor driven actuator provide complete actuator details, dimensions, schematics, wiring diagrams, weights, operating speed, motor currents at the specified voltage for each actuator, corresponding to locked rotor, maximum seating torque, average running load and speed.

3. Erection Drawings. Erection drawings shall include the procedures to be used in setting, supporting, and/or anchoring the valves, the fitting of line pipe to the valves for proper coupling, and for adjusting and testing all valve assemblies.

PART 2 - PRODUCTS

2.01 OPERATORS

A. General. All valves shall be equipped with operators. The operators shall be sized based on the maximum expected torque as per valve manufacturer's recommendations. The responsibility for proper operation shall reside with valve supplier. When the maximum force required to operate a valve under full operating head exceeds 40 pounds, gear reduction operators shall be provided. Gear operators shall be totally enclosed and lubricated. All valves shall open by turning counterclockwise.

1. Gate and Globe Valves: All gate, globe and angle valves shall be fitted with handwheels of suitable size or gear operators in accordance with the manufacturer's recommendation.

2. Chainwheel Operator: All Valves six feet or more above the floor level shall be provided with chainwheel operators in lieu of the handwheel operator and shall be the valve manufacturer's standard, with 316 SS chain to be furnished in the length required for operation.

3. Wrench Nut Operation: An AWWA nut or shaft key, as applicable shall be provided in lieu of handwheel where required for connection to extension stem and floor stand or as indicated on the Drawings. Nut shall be constructed of cast iron. No submerged or buried operator shall require maintenance following installation. Suitable gaskets, O-rings, and other features shall ensure permanent watertightness.
   a. Buried service operators on valves larger than 2-½ inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Provide gear operators on all valves from 6 inches and up and high reduction (special) gear operators on 10" and larger valves. All moving parts of the valve and operators shall be enclosed in a housing to prevent contact with the soil.
   b. Buried service operators for quarter-turn valves shall be designed to withstand 450 foot-pounds of input torque at the fully open or fully closed positions without damage to the valve or operator and shall be grease packed and gasketed to withstand a submersion in water to 10psi.
   c. Valves shall be installed with extension stems, as required, and valve boxes.

4. On quarter-turn valves, the valve operators shall be of the self-locking type to prevent the disc or plug from creeping and shall be provided with position indicators to show the position of the valve disc or plug. Operators of the worm and gear type shall have self-locking, worm gears, one-piece design, of bronze gear material, accurately machine cut. The worm shall be hardened alloy steel with thread ground and polished. Operators of the geared traveling nut type shall have threaded steel reach rods with an internally threaded bronze or ductile nut.

5. Valves provided with motor operators shall be provided as a complete unit from the valve supplier. All valve motor operators shall be provided from the same manufacturer.

2.02 VALVES

A. Gate Valves: Gate valves, 2½ inch diameter and smaller have screwed or solder ends as required and shall be Type 304 stainless steel solid wedge, union bonnet, rising stem gate valves such as Figures 47 and 48 as manufactured by Jenkins Brothers or equal products as manufactured by Kennedy Valve Manufacturing Company, Crane or equal. Valves shall be rated 200 psi.

B. Gate valves 4-inches through 12 inches in size shall be resilient-seated, non-rising stem type with 2-inch operating nuts for buried service and handwheels for exposed service conforming to AWWA Standard C-509.

C. Metal Ball Valves (4-Inch and Smaller): Ball valves up to 1-1/2-inch (incl.) in size shall have bronze 2-or 3-piece bodies with screwed ends for a pressure rating of not less than 600 psi WOG. Valves 2-inch to 4-inch in size shall have bronze 2-or 3-piece bodies with 125 lb or 150 lb flanged ends per ANSI B 16.1unless otherwise indicated. The balls shall be solid chrome plated brass or bronze, or stainless steel, with full port openings. The valve stems shall be of the blow-out proof design, stainless steel, with reinforced Teflon seal. The valve seats shall be of Teflon or Buna-N, for bi-directional service and easy replacement. Ball valves shall be as manufactured by ITT Engineered Valves; NIBCO, Inc or equal.

D. Wastewater Pump Control Valve. Pump control valves shall be provided with electric actuator pressure transducer and PLC pump control panel as a as a complete system package from a single manufacturer.

1. The Pump Control Valve shall have flanged connections, a globe body configuration, and have a single seat with seat bore equal to size of valve. The minimum travel of the piston shall be equal to 25% of the diameter of the seat. For true alignment (to correct lateral thrust and stem binding) the piston shall be guided above the seat a distance equal to no less than 75% of the diameter of the seat. Piston shall be cushioned and so designed as to insure positive closure. The spring(s) shall be enclosed in a protective chamber to close the main valve upon power failure. A mechanical scraper ring shall be utilized to protect the internal seals. Brass bushings with gauge cock on inlet and outlet of main valve shall be provided to receive pressure gauges for testing purposes. The design shall be such that repairs and dismantling of main valve may be made without its removal from the line. The valve shall be constructed from gray iron castings that conform to ASTM Specification A 126 Class B. Bronze parts shall conform to ASTM Specification B-62, and stainless parts shall conform to ASTM Specification A743 Grade CF-8 or CF 8M. The main valve shall be packed with a resilient seat packing and Buna-N O-ring seals to insure tight closure and prevent metal to metal friction and seating. The seat ring shall be grade 300 series stainless steel and shall be held in place via grade 300 series stainless steel fasteners. The seat support assembly shall be grade 300 series stainless steel. The flanged assemblies shall conform to ANSI standards for wall thickness of body caps, and flange thickness and drilling, subject to other specified standards. Ferrous surfaces of valve shall be coated with NSF Certified Epoxy (Tnemec Series N140F) in accordance with ANSI/NSF Std. 61, and conforms to AWWA D102 Inside System No. 1.

2. Electric actuator shall be as recommended by the valve manufacturer and suitable for torque and thrust requirements for proper valve operation. Provide NEMA 6 enclosure suitable for temporary submergence. Include an emergency hand wheel for emergency use.

3. Control panel for each valve shall be provided to coordinate pump start/stop operation using automatic throttling of the valve operation to maintain a pressure setpoint as set by a 4-20mA pressure transducer.
   a. The control system shall be housed within a fiberglass NEMA 4X waterproof and rustproof enclosure that will be mounted remote from the valve location.
   b. All components of this system including control switches, terminal blocks, interface fusing, the message center display, the PLC, and all associated components of the PLC shall be UL and CSA approved. All PLC inputs shall be 120V signals.
   c. The PLC module shall provide a green numbered LED for each corresponding input to indicate signal status.
      i) The following inputs shall be provided from the field devices as a minimum requirement:
         - Control Switch: Pilot device to start/stop.
         - Valve Open Limit Switch: Actuated when valve is 95% closed - (wired to normally closed contact of the switch to provide 120 volt signal as the valve opens)
         - System Pressure Switch: Senses pump discharge pressure
         - Pump Start Interlock: Provides a dry contact input signal when pump motor starter is energized
         - Valve Mounted Pressure Transducer: Provides a 4-20 mA signal to the PID control for control of valve inlet pressure or pumping pressure.
         - Valve Full Open Signal: Customer supplied contract to open the valve fully when the pump is running.
      ii) The following outputs shall be provided to the field devices:
         - Pump Motor Starter (Dry Contacts): Enables Pump Motor Starter to energize
         - Open Valve: When activated - opens valve
         - Close Valve: When activated - closes valve
      iii) All inputs and outputs are field wired to numbered terminal boards in the control panel
   d. The control system shall incorporate a message center display to indicate valve and system status. The following messages shall be included:
      - SYSTEM READY -
      - CONTROL SWITCH OFF
      - PUMP STARTING
      - WAITING FOR PRESSURE
      - CURRENT OPERATING PRESSURE
      - VALVE OPENING
      - SYSTEM NORMAL - VALVE OPEN
      - VALVE CLOSING
      - PUMP STOPPED
      - VALVE FAIL - STARTING
      - VALVE FAIL - RUNNING
      - ABNORMAL PRESSURE - STARTING
      - ABNORMAL PRESSURE - RUNNING

- PUMP MOTOR - FAILURE
- RESTART DELAY - 5 MINUTE - OR RESET H-O-A

e. Provide four (4) independent relay contacts that will close given various errors detected by the PLC.

f. Include System alarms highlighted by a flashing display describing the system fault. Upon fault detection, the system will undergo a safety shutdown. After all faults have been investigated for their causes and corrections, the control panel must be manually reset via the HAND-OFF-AUTO switch to clear all errors and enable the system for normal operation.

g. Furnish battery backup to prevent loss of internal memory upon loss of power. Furnish a new lithium battery with a minimum life expectancy of at 1 year. Battery failure is indicated by the LED in the control panel of the PLC and an error message on the display.

h. Provide remote communication via standard modem or PCMCIA Card modem to allow for remote monitoring, troubleshooting, and programming.

4. Wastewater Pump Control Valves shall be as manufactured by Ross Valve Mfg. Co., Model 70SWR-S–CE with electric actuator model 3 FCK-3 and model MC-2001P-010-005 pump control panel, or Equal with pressure setting indicator option.

E. Sewage Air and Vacuum Valves.

1. Sewage Air and Vacuum Relief Valves shall consist of a compact tubular all stainless steel fabricated body, hollow direct acting float and solid large orifice float in H.D.P.E. – stainless steel nozzle and woven dirt inhibitor screen, nitrile rubber seals and natural rubber seat.

2. The valve shall have an integral "Anti-Surge" Orifice mechanism which shall operate automatically to limit surge pressure rise or shock induced by closure to less than 1.5 times the valve rated working pressure. The intake orifice area shall be equal to the nominal size of the valve (i.e., a 6" valve shall have a 6" intake orifice).

3. Large orifice sealing shall be affected by the flat face of the control float seating against an EPDM rubber "O" ring housed in a dovetail groove circumferentially surrounding the orifice. Discharge of pressurized air shall be controlled by the seating and unseating of a small orifice nozzle on an EPDM rubber seal affixed into the control float. The nozzle shall have a flat seating land surrounding the orifice so that damage to the rubber seal is prevented.

4. The valve construction shall be 304 stainless steel and shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to twice the designed working pressure. Connection to the valve inlet shall be facilitated by flanged ends conforming ANSI B16.1 Class 150 or ANSI B16.5 Class 150 Standards. Flanged ends shall be fastened with stainless steel bolts inserted for alignment to the specified standard, nuts, washers and gaskets. Valve outlet shall be a swivel flange outlet for connection to vent piping.

5. Operation of the valve shall be as follows:
   a. Prior to the ingress of liquid into the valve chamber, as when the pipeline is being filled, valves shall vent through the large orifice to a transient pressure rise, on valve closure, of <1.5 x valve rated pressure. At higher sewage/effluent approach velocities, which have a potential to induce transient pressure rises greater than 1.5 times valve rated

pressure on valve closure the valve shall automatically discharge air/gas through the "Anti-Shock" Orifice and reduce sewage/effluent approach velocity, so that on closure a maximum transient pressure rise of less than 1.5 times valve rated pressure is realized.

b. Valves shall not exhibit leaks or weeping of liquid past the large orifice seal at operating pressures of 7.2 psi to twice rated working pressure. Valves shall be provided with a bias mechanism.

c. Valves shall respond to the presence of air/gas by discharging it through the small orifice at any pressures within a specified design range, 7.2 psi to 145 psi and shall remain leak tight in the absence of air.

d. Valves shall react immediately to pipeline drainage or liquid column separation by the full opening of the large orifice so as to allow unobstructed air intake at the lowest possible negative internal pipeline pressure.

6. Sewage air and vacuum relief valves shall be Vent-O-Mat Series RGX or equal,

F. Check Valve

1. Check Valves shall be suitable for cold working pressures of 250 psig, designed for wastewater, abrasive, and slurry service. The check valve shall be of the full body type, with a domed access cover and only one moving part, the flexible disc.

2. The valves shall be designed, manufactured and tested in accordance with American Water Works Association Standard ANSI/AWWA C508.

3. The Valves shall be provided with flanges in accordance with ANSI B16.1, Class 125.

4. Valve Design

a. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve for valves larger than 3". The seating surface shall be on a 45 degree angle to minimize disc travel.

b. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

c. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a memory disc return action to provide a cracking pressure of 0.25 psig.

d. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures.

e. A screw-type backflow actuator shall be provided to allow opening of the valve during no-flow conditions. Buna-N seals shall be used to seal the stainless steel stem in a Lead-Free bronze bushing. The backflow device shall be of the rising-stem type to indicate position. A stainless steel T-handle shall be provided for ease of operation.

f. A bottom mounted oil dashpot (oil cushion) shall be provided to provide hydraulic control of the final 10% of valve closure and reduce valve slam and water hammer normally associated with rapid flow reversal conditions on pump shut down. The dashpot shall consist of a high pressure hydraulic cylinder, adjustable external flow

control valve, oil reservoir, pressure gauge, stainless steel air inlet valve, and piping designed to control the closing speed of the last 10% of travel in 1-5 seconds. A threaded brass dashpot bushing unit with a grease fitting for lubrication shall connect the cylinder to the valve and shall have an air gap to prevent hydraulic fluid from entering the valve and contaminating the water system. A snubber rod fitted with O-ring seals and rod wiper scrapers shall make contact with the lower portion of the disc's stainless steel strike plate.

5. Materials
   a. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B for 30 in. and larger.
   b. The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG.
6. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage.
7. The exterior and interior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.
8. Check Valves shall be Swing-Flex Check Valves, Series #500 as manufactured by Val-Matic Valve & Mfg. Corporation or equal.

G. Butterfly valves

1. Butterfly valves shall be short body, conforming to AWWA C504, Class 150B. Minimum working differential pressure across the valve disc shall be 150 psi.
2. Each valve body shall be tested under a test pressure equal to twice its design water working pressure.
3. Valves shall be bubble tight at rated pressures and shall be satisfactory for throttling service and frequent operation after long periods of inactivity. Valve discs shall rotate 90 degrees from the full-open position to the tight-shut position.
4. Valve Ends
   a. Buried: Mechanical joint
   b. Exposed: Flanged Class 125, ANSI B16.1.
5. Valve shafts: shall be carbon steel with Type 316 stainless-steel journals and static seals. Valve shafts shall be dual stub shafts or a one-piece shaft extending completely through the valve disc.
6. Actuator: Enclosed, gasketed gear, type fully grease packed with stop in open/closed position.
   a. Manually-actuated butterfly valves, 4 inches and larger, shall be equipped with gear actuators. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque.
   b. Motor actuated valves shall be provided with motor actuators as herein.
7. The rubber seat shall be an integral part of the valve body. Rubber seats fastened to the disc by any means shall not be permitted.
8. Materials of construction shall be as follows:
   a. Body: Cast iron, ASTM A126, Class B
   b. Shaft: Carbon steel with ASTM A276, Type 316 stainless steel journals and static seals.

c. Disc: cast iron, ASTM A126, Class B or ductile iron, ASTM A536.

9. Manufacturer: Henry Pratt Company, Clow Valve Company, Dressor Industries, Dezurik, or equal.

H. Eccentric plug valves

1. General
   a. Valves shall be of the nonlubricated eccentric type with resilient-faced plugs and shall be furnished with end connections as shown on drawings. Flanged valves shall be faced and drilled to the ANSI 125/150 lb standard.
   b. Port areas for valves through 20 inches shall be minimum 80 percent of full pipe area and not less than 70 percent for larger valves.
   c. Valve pressure ratings shall be a minimum of 175 psi.
   d. Drop tight shutoff should be provided at full-rated working pressure in the normal flow direction and 50 psi in the other direction.
   e. Certified copies of proof-of-design test reports shall be furnished as outlined in AWWA C504, Section 5.5.
   f. Valves shall be Dezurik, Golden Anderson, or equal.
2. Valve Body
   a. Valve bodies shall be of ASTM A126 Class B cast iron in compliance with AWWA C504 Section 2.2.
   b. Bodies in 3 inches and larger valves shall be furnished with a welded overlay seat of not less than 90 percent pure nickel in accordance with AWWA C507 Section 7.2.
   c. Valves utilizing resilient seats attached to the body shall not be acceptable. As per AWWA C504 Section 35.2 and AWWA C507 Section 7.2, sprayed of plated sets are not acceptable, nor shall screwed in seats be acceptable.
3. Plugs
   a. Each valve plug shall rotate 90 percent from the fully open to the tightly shut position and shall seat at an angle of 90 percent from the pipe axis in which the valve is installed.
   b. Plugs shall be of ASTM A216 Class B cast iron in compliance with AWAA C504, Section 2.2.
   c. The plug shall be of one piece construction and shall be capable of withstanding the full pressure rating of the valve without use of additional structural reinforcing ribs that extended beyond the profile of the plug itself.
   d. Plugs shall be resilient faced with neoprene or hycar, suitable for use with raw sewage.
   e. Plugs with cast inlays shall not be acceptable.
4. Bearings
   a. Valves shall be furnished with replaceable, sleeve-type metal bearings conforming to AWWA C504, Section 3.6 and AWWA C507, Section 8.
   b. Bearing shall be of sintered, oil-impregnated and permanently lubricated Type 316 ASTM A743 Grade CF-8M or AISI Type 317L stainless steel in up to 36 inch size.
   c. For valves larger than 36 inches, the upper and lower plug journals shall be fitted with ASTM A240 Type 316 stainless sleeves with bearings of ASTM B30, Alloy C95400 aluminum bronze.
   d. Nonmetallic bearings shall not be acceptable.

5. Packing Seals
   a. Valves shaft seals shall be of the multiple V-ring type and shall be externally adjustable, repackable without removing the bonnet or actuator from the valve, and repackable under pressure.
   b. Shaft seals shall conform with AWWA C504, Section 3.7 and AWWA C507, Section 10.2.
   c. Valves utilizing O-ring seals or nonadjustable packing shall not be acceptable.
   d. All exposed nuts, bolts, springs, washers, etc., shall be stainless steel for buried valves and zinc plated for all others.
6. Valve Operators
   a. Manually-actuated plug valves, 4 inches and larger, shall be equipped with gear actuators. All gearing shall be enclosed in a semi-steel housing and be suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt and water into the actuator. Actuators shall clearly indicate valve position and an adjustable stop shall be provided to set closing torque.
   b. Motor actuated valves shall be provided with motor actuators as specified below.

I. Backflow Preventer:

1. Backflow preventers shall be the reduced pressure type, providing protection during the emergency conditions of either back-siphonage or backpressure or a combination of both. Backflow preventers shall be certified by a nationally recognized testing laboratory as conforming to current requirements of ASSE 1013, AWWA C 506, or USC-FCCC. The installation shall meet all applicable state and local code.
2. Sizes ¾-inch through 2-inches shall have bronze bodies with threaded connections, a bronze union on either side and a strainer installed upstream of the device. Gate valves shall be installed upstream and downstream of the device.
3. Sizes 2½ inches and larger shall be bronze with corrosion resisting moving parts and trim and flange connections. Gate valves shall be installed upstream and downstream of the device.
4. The device shall be equipped with three leak-proof test cocks. A fixed air gap, or funnel, shall be installed at the relief port. A drain line shall be piped from the discharge side of the air gap as shown on the Drawings and shall be supported independently from the device.
5. Backflow preventers shall be rated at a minimum 175 pounds cold water working pressure.
6. Backflow preventers shall be manufactured by Watts, Wilkins, Hersey or equal.

J. Pressure Reducing Valves

1. Provide bronze body, spring controlled, adjustable pressure reducing valve with threaded connections for sizes 2-inch and smaller.
2. Provide valves with high temperature diaphragm and renewable nickel alloy seat.
3. Provide with thermal expansion bypass.
4. Provide with separate bronze strainer with 20 mesh 316 stainless steel basket. Attach to valve with bronze nipple.

5. Rated for 300 psig maximum inlet water pressure with adjustable 25-75 psig outlet water pressure.

6. Pressure reducing valves shall be Watts 223SB or equal.

K. Pressure Gauges: Pressure gauges shall be non-liquid filled, bourdon tube type, ranged 0 to 200 psig. Case shall be solid front, plastic, non-liquid filled, 4-1/2" diameter with blow-out protection. All wetted parts shall be type 316 stainless steel. Accuracy shall be +/- 0.5 percent of range. Process connection shall be bottom, ½" NPT male. Pressure gauges shall have external adjustment. Provide 316 SS isolation diaphragm for pressure gauges in wastewater service. Pressure gauges shall be equal to Ashcroft Industrial Instruments.

L. Pressure Relief Valve

1. The pressure relief valve shall open when the inlet water pressure exceeds a set maximum level. It shall relieve to maintain that pressure and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a spring and hydraulically operated, direct acting, adjustable, diaphragm or piston type globe or angle valve as indicated on plans.

2. For inlet sizes 2-1/2 inch and smaller, the valve body shall be bronze with threaded inlet and outlet to standard NPT and with flanged top, suitable for an inlet pressure of 300 psi. The spring shall be adjustable with an adjusting screw, to regulate the pressure setting.

3. For inlet sizes 3-inch and larger, the valve body shall be carbon steel with flanged inlet and outlet and flanged top, suitable for an inlet pressure of 300 psi. The spring shall be adjustable with an adjusting screw, to regulate the pressure setting.

4. The valve trim shall be of stainless steel with stainless steel spring. The rubber seat shall be replaceable.

5. The valve shall be settable for a minimum relief pressure of 25 psi.

6. Pressure relief valves shall be equal to Cla-Val Company, OR Golden-Anderson OR Ross Valve Mfg. Co., Inc

2.03 MOTOR ACTUATED VALVES

A. General

1. Actuators shall be designed for use on the power supply as specified in the valve schedule and are to incorporate motor, integral reversing starter, local control facilities and terminals for remote control and indication connections housed within a self-contained, sealed enclosure.

2. In order to maintain the integrity of the enclosure, setting of the torque levels, position limits and configuration of the indication contacts etc. shall be carried out without the removal of any actuator covers over an Infra red interface. Sufficient commissioning tools shall be provided with the actuators and must meet the enclosure protection and certification levels of the actuators. Commissioning tools shall not form an integral part of the actuator and must be removable for secure storage. In addition, provision shall be made for the protection of configured actuator settings by a means independent of access to the commissioning tool.

3. The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

B. The actuator shall be sized to guarantee valve closure at the specified differential pressure and temperature. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. For linear operating valves, the operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute unless otherwise stated in the data sheet. For 90° valve types the operating time will be specified.

C. Environmental

1. Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from 0°F) to 140°F, up to 100° relative humidity.
2. Actuators for hazardous area applications shall meet the area classification, gas group and surface temperature requirements specified in the schedule.

D. Enclosure

1. Actuators shall be 0-ring sealed, watertight to /IP68 7m for 72hrs, NEMA 4, 6. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed for site cabling, the terminal compartment having the same ingress protection rating as the actuator with the terminal cover removed.
2. Enclosure must allow for temporary site storage without the need for electrical supply connection.
3. All external fasteners shall be zinc plated stainless steel.

E. Motor

1. The motor shall an integral part of the actuator, designed specifically for valve actuator applications. It shall be a low inertia high torque design, class F insulated with a class B temperature rise giving a time rating of 15 minutes at 104°F at an average load of at least 33% of maximum valve torque. Temperature shall be limited by thermostats embedded in the motor end windings and integrated into its control.
2. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gearcase.
3. Motor protection shall be provided as follows:
   a. Stall - the motor shall be de-energized within 8 seconds in the event of a stall when attempting to unseat a jammed valve.
   b. Over temperature - thermostat will cause tripping of the motor. Auto-reset on cooling
   c. Single phasing - lost phase protection.
   d. Direction – phase rotation correction.

F. Actuator gearing shall be totally enclosed in an oil-filled gearcase suitable for operation at any angle. Grease lubrication is not permissible. All drive gearing and components must be of metal construction and incorporate a lost-motion hammerblow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design should be such as to permit the opening of the gearcase for inspection or disassembled without releasing the stem thrust or taking the valve out

of service. For 90° operating type of valves drive gearing shall be self locking to prevent the valve backdriving the actuator.

G. Hand operation

1. A handwheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The handwheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.
2. Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated in the data sheet. For linear valve types the actuator handwheel drive must be mechanically independent of the motor drive and should be such as to permit valve operation in a reasonable time with a manual force not exceeding 400N through stroke and 800N for seating/unseating of the valve.

H. Torque and turns limitation to be adjustable as follows:

1. Position setting range – multi-turn: 2.5 to 100,000 turns, with resolution to 15 deg. of actuator output.
2. Position setting range – direct drive part turn actuators: 90° +/-10°, with resolution to 0.1 deg. of actuator output.
3. Torque setting: 40% to 100% rated torque.
4. Measurement of torque shall be from direct measurement of force at the output of the actuator.

I. Remote valve position/actuator status indication.

1. Four contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or open contact form. Contacts shall maintain and update position indication during handwheel operation when all external power to the actuator is isolated.
2. The contacts shall be rated at 5A, 250V AC, 30V DC.
3. As an alternative to providing valve position any of the four above contacts shall be selectable to signal one of the following:□
   a. Valve opening, closing or moving
   b. Thermostat tripped, lost phase
   c. Motor tripped on torque in mid travel, motor stalled
   d. Remote selected
   e. Actuator being operated by handwheel
4. Provision shall be made in the design for an additional 4 contacts having the same functionality.

5. Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel for remote indication when required. The transmitter will auto range to the set limits

J. Local position indication

1. The actuator display shall include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully closed in 1% increments. Valve closed and open positions shall be indicated by symbols showing valve position in relation to the pipework to ensure that valve status is clearly interpreted. With main power on the display shall be backlit to enhance contrast at low light levels and shall be legible from a distance of at least 6 feet (2m).
2. Red, green, and yellow lights corresponding to open, closed, and intermediate valve positions shall be included on the actuator display when power is switched on. The digital display shall be maintained and updated during handwheel operation when all power to the actuator is isolated.
3. In addition, the actuator display shall include a separate text display element with a minimum of 32 characters to display operational, alarm and configuration status. Provision shall be made to orientate the actuator display through increments of 90□.

K. The digital display shall be capable of indicating real time torque and valve position simultaneously, both being displayed in 1% increments of valve position and actuator rated torque. In addition torque shall also be displayed in horizontal bar graph form.

L. The reversing starter, control transformer and local controls shall be integral with the valve actuator suitably housed to prevent breathing and condensation. The starter shall be suitable for 60 starts per hour and of rating appropriate to motor size. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tappings and be adequately rated to provide power for the following functions:

1. Energization of the contactor coils.
2. 24V DC output for remote controls.
3. Supply for all the internal electrical circuits.

M. Local controls

1. The actuator shall incorporate local controls for Open, Close and Stop and a Local/Stop/Remote mode selector switch lockable in any one of the following three positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.
2. The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.
3. Provision shall be made to orientate the local controls through increments of 90□.

N. Control facilities

1. The necessary control, wiring and terminals shall be provided in the actuator for the following functions:
2. Open and close external interlocks to inhibit local and remote valve opening and/or closing control. It shall be possible to configure the interlocks to be active in remote control only.
3. Remote controls fed from an internal 24V DC supply for any one or more of the following methods of control:
   a. Open, Close and Stop control.
   b. Open and Close maintained or "push to run" (inching) control.
   c. Overriding Emergency Shut-down to Close (or Open) valve from a normally closed or open contact.
   d. Two-wire control, energize to close (or open), de-energize to open (or close).
4. It shall be possible to reverse valve travel without the necessity of stopping the actuator. The motor starter shall be protected from excessive current surges during rapid travel reversal.
5. Provision shall be made for operation by distributed control system utilizing the following network systems.
   a. Modbus
   b. Profibus
   c. Foundation Fieldbus
   d. DeviceNet
   e. Pakscan

O. Monitoring facilities

1. Facilities shall be provided for monitoring actuator operation and availability as follows:
   a. Monitor (availability) relay, having one change-over contact, the relay being energized from the control transformer will de-energise under any one or more the following conditions:
   b. Loss of main or customer 24V DC power supply
   c. Actuator control selected to local or stop
   d. Motor thermostat tripped
   e. Actuator internal fault
2. Actuator text display indication of the following status/alarms:
   a. Closed Limit, open limit, moving open, moving closed, stopped
   b. Torque trip closing, torque trip opening, stalled
   c. ESD active, interlock active
   d. Thermostat trip, phase lost, 24V supply lost, Local control failure
   e. Configuration error, Position sensor failure, Torque sensor failure
   f. Battery low, power loss inhibit
3. Integral datalogger to record and store the following operational data:
   a. Opening last /average torque against position
   b. Closing last /average torque against position

c. Opening motor starts against position
d. Closing motor starts against position
e. Total open/closed operations
f. Maximum recorded opening and closing torque values
g. Event recorder logging operational conditions (valve, control and actuator)

4. The datalogger shall record relevant time and date information for stored data.
5. Datalogger data is to be accessed via non-intrusive IrDA communication. Sufficient standard intrinsically safe tools shall be provided for downloading datalogger and actuator configuration files from the actuators and subsequent uploading to a PC. The actuator manufacturer shall supply PC software to enable datalogger files to be viewed and analyzed.

P. Wiring and terminals

1. Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end.
2. The terminals shall be embedded in a terminal block of high tracking resistance compound.
3. The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight seal and shall be provided with a minimum of 2 threaded cable entries with provision for a maximum of 4.
4. All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable.
5. A durable terminal identification card showing plan of terminals shall be provided attached to the inside of the terminal box cover indicating:
   a. Serial number
   b. External voltage values
   c. Wiring diagram number
   d. Terminal layout
   e. The code card shall be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period. In addition, sufficient actuator commissioning tools shall be supplied to enable actuator set up and adjustment during valve/actuator testing and site installation commissioning.

Q. Performance test certificate

1. Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load, and the following parameters should be recorded.
   a. Current at maximum torque setting
   b. Torque at max. torque setting
   c. Flash test voltage
   d. Actuator output speed or operating time.

2. In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.

R. Failsafe Integral Battery Backup

1. When specified in the valve schedule, the actuator shall provide valve failsafe operation by utilizing power from a battery source during AC supply mains failure. Under normal supply conditions the actuator operates from the AC electrical supply. On loss of electrical supply the actuator shall automatically switch over to receive power from a 24V DC battery supply allowing control of the valve to the specified failsafe position
2. The failsafe battery backup shall include a battery located in the actuator terminal cover, charged from an integral charging system when AC power is applied to the actuator. On loss of the normal AC supply the actuator shall automatically switch over to the 24V DC battery supply
3. Failsafe actuator operation shall be as specified in the valve schedule and shall be user configured to respond as follows:
   a. Automatic close on loss of supply
   b. Automatic open on loss of supply
   c. Stayput waiting for local or remote control command
4. Failsafe control or positioning shall be completed within 30 minutes of loss of AC supply and designed to prevent deep discharge damage to the batteries. Remote operation is by hardwired control systems only, derived from and external supply source as the actuator 24V DC supply is not supported under battery operation.
5. Batteries shall be lead-acid type designed to supply adequate power to operate valve through at least 4 cycles.
6. Battery backup system shall include charge state indication for depleted, low and full charge indication

2.04 WATER SERVICE LINE FITTINGS AND APPURTENANCES

A. Service Saddles, conforming to AWWA C800.

1. Ductile Iron
   a. For 1-inch diameter and smaller taps provide single strap saddles for mains 4-inch through 12-inch in diameter and double straps for mains larger than 12-inches in diameter.
   b. Body: Ductile iron ASTM-A536, threaded for corporation stop.
   c. Bolts, nuts and washers: Galvanized steel ASTM B633.
   d. Gaskets: Buna N.
2. Bronze
   a. For 1-inch diameter and smaller taps provide single strap saddles for mains 4-inch through 12-ince in diameter and double straps for mains larger than 12-inches in diameter.
   b. Body: Cast Bronze ASTM B584 threaded for corporation stop.

c. Bolts and nuts: Copper silicon alloy 651 ASTM B98.

d. Washers: Silicon Bronze, ASTM B36

e. Gaskets: Buna N.

3. Nylon Coated Ductile Iron

a. For 1-inch diameter and smaller taps provide single strap saddles for mains 4-inch through 12-inch in diameter and double straps for mains larger than 12-inches in diameter.

b. Body: Ductile iron ASTM-A584, threaded for corporation stop.

c. Bolts, nuts and washers: Type 304 stainless steel.

d. Gaskets: Buna N.

4. Service saddles installed on C900 PVC pipe shall be a 2 casting designed for use with the specified O.D. of the pipe. Each saddle shall accurately fit the contour of the pipe O.D. without causing distortion of the pipe. The sections shall be securely held in place with bolts, washers and nuts. The casting sections shall be tapped to receive the bolts.

B. Corporation Stops

1. Corporation stops shall be bronze body.

2. End connections shall conform with AWWA C800.

3. The inlet fitting shall be an iron pipe thread when used with a saddle and the outlet shall be an iron pipe thread to match the service line.

4. Size shall match service tap and service line.

2.05 HYDRANTS

A. Post Hydrants.

1. Post Hydrants shall be self-draining, non-freezing, compression type with 2-3/16-inch main valve opening. Inlet connection shall be 3-inch mechanical joint. Outlet shall be 2.5-inch.

2. Hydrants shall have a 3-inch ductile pipe riser with a cast iron stock top and a non-turning operating rod. Principal interior operating parts shall be brass and removable from the hydrant for servicing without excavating the hydrant.

3. Hydrants shall be set in 4 cubic feet of crushed stone to allow for proper drainage of the hydrant. Installation of the hydrants shall be in conformance with AWWA's recommendations.

4. Post hydrants shall be equal to Eclipse No.2 Post Hydrants as manufactured by The Kupferle Foundry Company.

B. Yard Hydrants.

1. Yard Hydrants shall be self-draining, non-freezing type. Inlet connection shall be 1-inch.

2. Yard Hydrants shall be Well Pro Hi-Capacity series WC-1000 or equal.

2.06 TAPPING SLEEVES AND VALVES

A. Tapping sleeve to be manufactured form gray iron ASTM A126 Grade B or ductile iron ASTM A536 65-45-12, with high strength low alloy steel zinc coated ASTM B-633 bolts and nuts.

B. Tapping valve shall conform to requirements AWWA C500 except as modified for passage and clearance of tapping machine.

1. Materials of construction shall be same as specified for gate valves in this section.
2. The mating valve flange must have a face to insure true alignment of valve and tapping machine.
3. The outlet end of the sleeve shall match connection to type of water main pipe.

2.07 VALVE BOXES

A. General. The Contractor shall provide cast-iron valve boxes.

B. Design.

1. Valve boxes shall be designed to be installed over each direct buried valve.
2. Boxes shall be of two piece extension type with slide-type adjustment and with flared base.
3. Covers shall be cast-iron and shall have cast-iron ring.
4. Box shall be of such length as will be adapted, without full extension, to the depth of the cover required over pipe at valve location.
5. Boxes shall be suitable for the valve size and depth of trench as recommended by the manufacturer

2.08 PROTECTIVE COATINGS FOR VALVES

A. Interior. Factory applied heat-cured epoxy coating conforming to AWWA C550, and field coat in conformance with Section 09900, Painting and Protective Coatings.

B. Exterior. Field coat exposed valves in conformance with Section 09900, Painting.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Aboveground valves shall be rigidly held in place using supports and hangers as shown on the Drawings and as specified. The stem orientation of valves in elevated piping shall be as approved by the Owner for accessibility, but no valve shall have stem in the downward direction. Saddle type valve supports shall be provided for all valves in vaults. Supports shall be of rugged construction providing at least 120 degrees under-support for the valve body, shall be constructed of steel as specified in Division 5, and shall be anchored to the foundations using galvanized anchor bolts.

3.02 TESTS

A. Field Tests. Test all valves and appurtenances for proper operating adjustments and settings and for freedom from vibration, binding, scraping, and other defects. The testing of the hydraulically and electrically controlled valves shall be supervised by a representative of the manufacturer who shall verify proper installation, adjustments, and performance. The adequacy of all pipe hangers and supports and valve supports to meet specified requirements shall be verified. All defects found shall be corrected as approved.

3.03 COORDINATION WITH INSTRUMENTATION

A. It shall be the responsibility of the Contractor to coordinate with Division 13 regarding the requirements of control valves.

3.04 COORDINATION WITH OTHER MECHANICAL SUPPLIERS

A. The installation and operation of the valve and motorized actuators shall be the unit responsibility of the valve supplier.

3.05 CLEANING

A. All valves and appurtenances shall be flushed clean of all foreign matter together with the piping as specified in other sections.

Motor Activated Valve Schedule

Valve Tag Number	FCV-203	FCV-501	FCV-504 and FCV-505	FCV-506 and FCV-507	FCV-511 to FCV-518	FCV-519	FCV-531 to FCV-533
Valve Type	Plug	Plug	Plug	Plug	Butterfly	Butterfly	Plug
Valve Size, Inches	30	48	12	20	6	8	8
Quality Standard	Dezurik or Equal	Dezurik or Equal	Dezurik or Equal	Dezurik or Equal	Dezurik or Equal	Dezurik or Equal	Dezurik or Equal
End Connection	Flanged	Flanged	Flanged	Flanged	Flanged	Flanged	Flanged
Valve Action on Loss of Power	Fail in Last Position	Fail in Last Position	Fail in Last Position	Fail in Last Position	Fail in Last Position	Close on Failure via Integral Battery Back-up	Fail in Last Position
Valve Speed	Adjustable	Adjustable	Adjustable	Adjustable	Manual Standard	Adjustable	Manual Standard
Service	Flow Return to Sewer	Jet Mix Pump Station/EQ Tank Isolation	Jet Mix Flush	Jet Mix Pump Isolation	EQ Flushing System	EQ Flushing System Isolation	EQ Flow Return Pump Drain
Fluid	Raw Wastewater	Raw Wastewater	Raw Wastewater	Raw Wastewater	Non-Potable Water	Non-Potable Water	Non-Potable Water
Flowrate (max)	20,900 gpm	46,500 gpm	3500 gpm	10,000 gpm	750 gpm	1500gpm	750 gpm
Differential Pressure (at Qmax)	80 ft	80 ft	80 ft	65 ft	80 psi	80 psi	80 ft
Valve Tag Number	FCV-203	FCV-501	FCV-504 and FCV-505	FCV-506 and FCV-507	FCV-511 to FCV-518	FCV-511 to FCV-518	FCV-531 to FCV-533

Other Requirements	Electric Actuator	Electric Actuator	Electric Actuator	Electric Actuator	Electric Actuator (modulating)	Electric Actuator	Electric Actuator
Additional Limit Switches	Open/Closed	Open/Closed	Open/Closed	Open/Closed	Open/Closed	Open/Closed	Open/Closed
Local-Off-Remote	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hand-Off-Auto Switch	No	No	No	No	No	No	No
Position Indicator Lights	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Potentiometer	No	No	No	No	Yes	Yes	Yes
Position Controller	No	No	No	No	Yes	Yes	Yes
Pushbutton Switches Open-Close-Stop	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maximum Open/Close Time	120 Seconds	180 Seconds	60 Seconds	120 Seconds	20 Seconds	30 Seconds	30 Seconds
Voltage	460/3/60	460/3/60	460/3/60	460/3/60	208/3/60	208/3/60	460/3/60
"In Remote" Status Contact for Local-Off-Remote Switch	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Modulating Valve Requirements

FCV-511 to FCV-518				
Liquid Sizing Data: Water		Max Flow	Normal Flow	Min Flow
Flow Rate	gpm	1100	750	500
Inlet Pressure	psig	40	45	48
Outlet Pressure	psi	15	10	7.5
Temperature	degrees F	70	70	70
Specific Gravity (SG)		1.0	1.0	1.0
Vapor Pressure	psia	0.36	0.36	0.36
Calculated Cv		220	137	87

END OF SECTION 15100

SECTION 15108
STOP LOGS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish and install fiberglass stop logs, guides and lifting devices as shown on the drawings and as specified herein.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Shop and erection drawings to include at a minimum parts list (identifying each component), dimensions, connection sizes and types and details of all accessory items
2. Certified setting plans, with tolerances, for anchor bolts.
3. Operating and maintenance instructions and parts lists.
4. Provide listing of reference installations as specified with contact names and telephone numbers.
5. Field testing procedures and equipment to be used.
6. Material Certification:
   a. Provide certification from the equipment manufacturer that the materials of construction to be provided are suitable for the service conditions specified and indicated. Provide proposed materials at no additional cost to the Owner.
   b. Where materials are not specified, provide technical data and certification that the proposed materials are recommended and suitable for the service conditions specified and indicated.

B. A copy of the contract mechanical process drawings covering the stop log locations with addenda that are applicable to the equipment specified in this section, marked to show all changes necessary for the equipment proposed for this specification section. If no changes are required, mark all drawings with "No changes required" or provide a statement that no changes are required.

1.03 QUALITY ASSURANCE

A. Stop logs, grooves and lifting devices shall be the product of one manufacturer.

B. Stop logs, grooves and lifting devices shall be the manufacturer's standard cataloged product and modified to provide the specification and the service conditions specified and indicated.

C. Welding: In accordance with American Welding Society Code or equivalent.

D. Provide services of manufacturer's representative in accordance with the requirements of the General Conditions of the Contract Documents and as specified herein. Manufacturer of stop logs must have at least ten (10) operating installations with stop logs of the size specified or larger and in the same service as specified operating for not less than ten (10) years.

1.04 DELIVERY, STORAGE AND HANDLING

A. Stop logs and accessories shall be stored and protected in accordance with the requirements of the General Conditions of the Contract Documents and manufacturer's recommendations.

B. Shipping:

1. Ship equipment, materials and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
3. The Contractor shall obtain spare parts from the manufacturer at the same time as pertaining equipment. The Contractor shall maintain possession of spare parts until Substantial Completion at which time all spare parts shall be turned over to the Owner.

C. Receiving:

1. Inspect and inventory items upon delivery to site.
2. Store and safeguard equipment, materials and spare parts in accordance with manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Plasti-Fab, Inc.

B. Ashbrook Simon Hartley

C. Or Equal

2.02 SERVICE CONDITIONS

A. Stop log sizes and operating data are indicated in the Stop Log Schedule as shown on the drawings.

2.03 FIBERGLASS STOPLOGS

A. Composition of the stop log laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship of the Society of the Plastics Industry, Inc. (SPI). And the Material Technology Institute (MTI) of the Chemical Process Industry for "Hand Lay-up Laminates," and shall meet the specifications for Type I, Grade 20 laminates shown in Appendix M-1 of said report.

B. All stop logs shall be flat and level. Warpage throughout the entire stop log shall not produce a crown of more than 1/16 inch in any direction. Visual inspection for defects shall be made without the aid of magnification. Defects shall be classified as to type and level as shown in Table I of ANSI/ASTM D2563-0, approved 1977, or any subsequent revision.

C. The stop log cover shall be fabricated so as to totally surround the internal structural matrix and protect it against corrosion from moisture or chemical deterioration. Stop logs shall be designed so that the maximum fiber stress (ultimate or yield, whichever applies) does not exceed 2.5 times the working stress. Stop logs shall be suitably reinforced to withstand the maximum seating head with a deflection less than L/360 of the gate width, or 1/4 inch, whichever is less. Stop logs with unseating heads shall be designed for a maximum deflection of 1/16". Stop log covers which are fabricated from pressed or laminated sheet material and glued to a substructure shall not be acceptable.

D. Fiberglass Reinforced Polyester (FRP) shall totally encapsulate an internal-reinforcing structure. To assure maximum service life, the copolymer composite shall be ultraviolet stabilized and seamless to protect inner structural members from corrosion. Structural characteristics for a minimum 1/8 inch glass mat laminate shall meet the following minimum physical properties:

Tensile strength	14,700 psi
Flexural modulus	800,000 psi
Flexural strength	23,300 psi
Impact strength	9.0 ft-lbs/in
Water absorption	0.13% (in 24 hours).

E. Each log shall be molded individually to the exact dimensions specified. Stop logs shall be manufactured of reinforced thermoset plastic containing ultraviolet absorbers. The surface shall be resin-rich to a depth of 0.010 inches to 0.020 inches and reinforced with C-glass or polymeric fiber surfacing material. The surface shall be free of exposed reinforcing fibers. The composition of these layers shall be approximately 95% (by weight) resin. The remaining laminate shall be made up of copolymer composite and reinforcing fibers in a form, orientation and position to meet the mechanical requirements. Structural reinforcing shall be utilized to attain the necessary stiffness to meet deflection requirements, and shall be well encapsulated with a laminate not less than 1/4 inch thick on each side to insure against any permeation by water to the core area. T-316 stainless steel lifting pins/eyes shall be bonded to the log with sufficient reinforcing to withstand the lifting force.

F. The stop logs shall be equipped with elastomeric top seals to seal between the logs. A special labyrinth seal shall also be fastened to the guide to form a watertight joint with the stop logs. Seals shall be made of molded or extruded virgin neoprene having a hardness of 55 - 65 Shore A Durometer.

G. Guides shall be styled for embedment, wall mounting or in-channel mounting as specified in the schedule and as needed to meet project requirements. Guides shall be fabricated from type 316 stainless steel and shall have a slot suitable for mating with the stop log. Guides to be bolted to the structure wall shall be equipped with heavy duty slotted clips for ease of mounting to the channel wall by means of type 316 stainless steel anchor bolts. Inverts shall be flush with the channel bottom.

H. All guides shall be factory assembled with bonded corners and reinforced with butt straps. The corner shall be capable of withstanding a torque of 200 foot pounds without damage.

I. Allowable maximum leakage rate shall be 0.2 gpm/sq.ft. of wetted perimeter

J. Frames shall be mounted as shown on the contract drawings.

K. A lifting beam with automatic latching hooks shall be provided for each stop log size. The lifting beam shall be built in such a manner as to automatically latch on to the stop logs when lowered into the guide frame. The lifting beam shall also have a tag line release mechanism. Hook pins shall be made of T-316 stainless steel. The beam and hooks shall be of Type 316 stainless steel.

L. Details, calculations, and drawings shall show the method of fabrication and verify that the logs will withstand any normal pressures or forces exerted without buckling or otherwise being damaged.

M. A storage rack shall be provided for storing stop logs when not in use. Storage rack shall be suitable for wall mounting.

PART 3 - EXECUTION

3.01 GENERAL

A. Prior to installation, protect stored stop logs, grooves and appurtenances from damage due to exposure to sunlight, heat, dirt, debris, vandalism.

1. Store stop logs, grooves and appurtenances in accordance with the manufacturer's written instructions.

B. Clean debris, dirt, and gravel from grooves and channels before placing stop logs in place.

C. Erect and support stop logs in respective positions free from distortion and strain during handling and installation. Inspect material for defects in workmanship and material. Clean out debris and foreign material from channels, grooves and seats, test lifting mechanisms to check proper functioning, and check nuts and bolts for tightness. Repair, stop logs and other equipment which does not operate easily or are otherwise defective.

D. Install stop logs in accordance with manufacturers printed instructions.

E. Ensure that grooves are straight and true so stop logs move easily and seat tight without binding.

3.02 MANUFACTURER SERVICES

A. Provide services of factory-trained service technician, certified by the manufacturer to service the type of equipment specified in accordance with the requirements of the General Conditions of the Contract Documents and as specified herein.

1. Service technician must have a minimum of five (5) years of experience, all within the last seven (7) years, servicing the type and size of equipment specified.
2. Service technician must be present on site for all items listed below. Work-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

3. Assistance during equipment installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures, inspection and checking of installation to furnish written approval of installation
   a. 1 work-day.

4. Training of Owner's personnel in the operation and maintenance of equipment as required. : Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom session.
   a. ½ work-day.

5. For the purposes of this paragraph, a work day is defined as an eight hour period at the project site, excluding travel time. The Engineer may request that a work day be furnished in a maximum of two trips.

6. Any additional time required of the factory trained service technician to assist in placing the equipment in operation or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

3.03 FIELD PERFORMANCE TESTS

A. The Contractor shall obtain suitable water for field testing of stop logs. The Contractor shall be responsible, at no additional cost to the Owner for provision of temporary piping, pumping, and other ancillary equipment necessary for delivery of water to the diversions structure for stop log testing purposes. Test water shall be disposed of as directed by the Owner.

B. After installation of stop log frames, and after inspection, operation, testing and adjustment have been completed by manufacturer's field service technician, install and remove each stop log from each frame (6 places) to demonstrate its ability to operate smoothly and without jamming.

C. Leakage Test: Test the stop logs in each of the frames for leakage. Maximum seating and unseating head measured from stop log invert, leakage not to exceed 0.2 GPM per linear foot of sealing length.

D. Promptly correct or replace all equipment not conforming to the requirements of this Section revealed by or noted during tests, at no additional cost to the Owner, and repeat tests until specified results are obtained. Contractor to provide all labor, piping, equipment, flowmeters and materials necessary for conducting tests. Following three unsuccessful test attempts, replace non-conforming equipment at no additional cost to the Owner.

E. Make all adjustments to place equipment in specified working order at time of above tests.

F. Conduct leakage test with water. Water for testing shall be furnished by Contractor.

END OF SECTION 15108

SECTION 15250
MECHANICAL INSULATION

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of mechanical insulation. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the Contractor's recommendations and as shown on the drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. The types of mechanical insulation specified in this Section include the following: Piping System Insulation - Flexible Unicellular.

D. Related Work Specified Elsewhere: Section 15050 - Basic Mechanical Materials and Methods, Section 15891 – HVAC Ductwork, Section 15910 – HVAC Ductwork Accessories.

1.02 REFERENCES

A. This Specification references the latest edition of the publications listed below. Work shall be performed and materials shall be furnished in accordance with these publications as reference herein:

1. American Society for Testing and Materials (ASTM) Standards.
2. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
3. National Fire Protection Association (NFPA) Standards.
4. NFPA 255 - Method of Test of Surface Burning Characteristics of Building Materials.
5. Underwriters Laboratories, (UL) Standards.
6. UL 723 Test for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Manufacturer's technical product data and installation instructions for each type of mechanical insulation:
   a. Manufacturer's product number.
   b. k-Value and thickness.

c. Accessories included for each mechanical system requiring insulation.

2. Maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required and whose products have been in satisfactory use in similar service for not less than 5 years.

B. Flame/Smoke Rating: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84, NFPA 255 method. Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150. Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

C. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

i) ASTM, American Society for Testing Materials.
ii) ASME, American Society of Mechanical Engineers.
iii) OSHA, Occupational Safety and Health Act.
iv) ANSI, American National Standards Institute.
v) AWWA, American Water Works Association.
vi) NFPA, National Fire Protection Association.
vii) FM, Factory Mutual Engineering Corporation.
viii) UL, Underwriters Laboratories, Inc.

1.05 STORAGE AND PROTECTION

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indices of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from Project site.

PART 2 - PRODUCTS

2.01 GENERAL

A. Ductwork Insulation Accessories:

1. Provide staple, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

B. Ductwork Insulation Compounds:

1. Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

C. Flexible unicellular piping insulation: ASTM C1 534, Type I.

2.02 ACCEPTABLE MANUFACTURERES

Insulation products shall be manufactured by CertainTeed, Knauf, Johns Manville, Owens-Corning, IMCOA, Pittsburgh-Corning and Armstrong.

2.03 PIPE INSULATION

A. Materials (Indoor Piping for Temperatures 150° F and Less)

1. Piping insulation shall be flexible elastomeric closed-cell type, slipped on the pipe prior to connection whenever possible. Where the slip-on technique is not possible, the insulation shall be pre-slit and snapped over the pipe with pre-applied adhesive. Butt joints shall be sealed with insulation manufacturer's adhesive or heat fuse method. Where required, the insulation shall be covered with insulation manufacturer's finish. Sealer shall be latex caulk. Thermal conductivity shall not exceed 0.27 BTU.in/hr/Ft2/°F at 75 degrees F.
2. Fittings shall be insulated using fabricated fitting covers of flexible elastomeric closed-cell type insulation in accordance with the manufacturer's instructions. Join slit seams and mitered joints with insulation manufacturer's adhesive or heat fuse method.

B. Materials (Outdoor Piping Exposed to Weather or in Pressure Regulating Stations)

1. Premolded cellular glass thermal insulation shall be furnished in accordance with ASTM C 552 and C 585 fabricated for standard pipe sizes, fittings and valves.
2. Maximum thermal conductivity of 0.32 BTU.in/hr/Ft2/°F at 70 degrees F in accordance with ASTM C 177 and C 518.
3. Maximum water vapor permeability of 0.00 perm-in when tested in accordance with ASTM E 96.
4. Average density of 8.0 lb/ft3.
5. Maximum Flame Spread Rating of 5 and Smoke-Developed Rating of 0 when tested in accordance with NFPA 255.
6. Utilize installation adhesives and joint sealants as recommended by the insulation manufacturer.
7. Install 30 gauge smooth Type 316 stainless steel jacketing over insulation retained by stainless steel bands.
8. Insulation products shall be equal to Pittsburgh Corning Foamglass.

C. Description: Piping insulation thickness shall be 1-inch for pipes up to 2-inches, 1-1/2-inches for pipes over 2-inches and up to 4-inches, and 2-inches for pipes over 4-inches.

2.04 DUCTWORK SYSTEM INSULATION

A. Insulate the following cold ductwork:

1. HVAC supply ductwork between fan discharge or HVAC unit discharge and room terminal outlets.
2. Insulate neck and bells of supply diffusers.
3. HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet.
4. HVAC plenums and unit housings not pre-insulated at factory or lined.

B. Insulate each ductwork system specified above with one of the following types and thickness of insulation:

1. Rigid fiberglass, 1-1/2" thick, increase thickness to 2" in machine, fan and equipment rooms with vapor barrier.
2. Flexible fiberglass, 1-1/2" thick, application limited to concealed locations with vapor barrier.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions under which mechanical insulation is to be installed. Work shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to Installer.

3.02 HVAC PIPING SYSTEM INSULATION

A. Insulate refrigerant suction piping systems with flexible unicellular, 1" thick for pipe sizes up to 1-1/2".

3.03 INSTALLATION OF PIPING INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure insulation serves its intended purpose:

1. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
2. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
3. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
4. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing and acceptance of tests.
5. Install insulation materials with smooth and even surfaces. Insulate each continuous run of

piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

6. Maintain integrity of vapor-barrier jackets on pipe insulation and protect to prevent puncture or other damage.

7. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

3.04 INSTALLATION OF DUCTWORK INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, these specifications and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

1. Install insulation materials with smooth and even surfaces.

2. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

3. Maintain integrity of vapor-barrier jackets on ductwork insulation and protect to prevent puncture and other damage.

4. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

5. Omit insulation on lined ductwork where internal insulation or sound absorbing linings have been installed, except as otherwise indicated.

B. Protect outdoor insulation exposed to weather by installing outdoor protective finish or jacketing as recommended by manufacturer.

C. Install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

END OF SECTION 15250

SECTION 15400
PLUMBING

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This Section includes the provision and installation of plumbing equipment, fixtures, specialties, and piping systems as shown on the Drawings and specified herein.

B. Work covered by this Section includes, but is not limited to:

1. Building internal potable water systems.
2. Building internal sanitary waste and vent systems.
3. Plumbing fixtures.
4. Plumbing equipment.

C. Sanitary drain inside building as covered under this specification shall be terminated 5'-0" outside the exterior walls for all drainage systems unless shown otherwise shown on the on the Drawings. Piping beyond 5'-0" is covered under Specification 15060.

D. Potable Water piping as covered under this specification shall be terminated at 1'-0" outside the exterior wall or floor. Piping beyond 1'-0" is covered under Specification 15060.

1.02 RELATED WORK

A. General Condition 28 – Working Drawings, Shop Drawings, Data on Material and Equipment, Samples, and Licenses.

B. 09900 -Painting

1.03 SUBMITTALS

A. Shop Drawings, Product Data, and Samples: Submit manufacturer's literature for all materials and equipment in accordance with requirements of DIV 1 and equipment specifications included in the Work. Required data shall include, but not necessarily be limited to :

1. Unit designation.
2. Unit dimensions and weight.
3. Complete electrical data including wiring diagrams.
4. Complete description of materials of construction including finishes.
5. Noise data for rotating equipment.

B. Operation and Maintenance Instructions: At completion of job, furnish copies of complete operations and maintenance instructions, neatly bound in leatherette covers. Label each cover with title and names Owner, AlE, and Contractor. Include complete description of operating and maintenance procedures required for all systems, controls, and equipment. Operation and

maintenance procedures for Owner-furnished/Contractor-installed equipment will be given to Contractor by Owner. Include these procedures in bound volumes.

1.04 QUALITY ASSURANCE

A. Fixtures, trim, and methods of piping and installation shall conform to local Plumbing Code. Fixtures in a given line shall be the product of one Manufacturer

B. Pipe, valves, fittings, and specialty items, unless otherwise specified, shall be new, full length, scale-free, and best quality of their respective kinds. In addition to tests required for specific materials and systems, manufacturer shall test or guarantee all materials to be as specified prior to delivery.

1.05 PRODUCT HANDLING, DELIVERY AND STORAGE

A. Receive and handle all materials with care so as not to cause damage. Use padded or strap slings, ect., as appropriate for materials being handled. Lift equipment by lift points provided or recommended by manufacturer.

B. Use proper tools, equipment, and procedures to handle and lay pipe. Do not damage pipe coating, wrapping, or linings. Repair or replace damaged pipe coatings, wrappings, or linings in accordance with manufacturer's instructions or as required to restore original protection.

C. Inspect all materials, upon receipt, for defects and for compliance with specifications.

D. Properly store all pipe, piping materials, etc., so as to prevent while in storage. Store all materials off ground or off floor. Store inside or cover all materials subject to deterioration from weather.

E. Store loose materials such as fittings, gaskets, bolts, nuts, small valves, traps, and specialties in adequate number of bins to properly separate. Protect ends of large fittings, valves, and pipe from weather and abuse. Properly grease all machined surfaces.

PART 2 - PRODUCTS

2.01 POTABLE WATER PIPING (CW,HW) / CONDENSATE DRAIN

A. Potable water piping 3 inches in diameter and smaller shall be as follows:

1. Tube:
   a. Aboveground: Type "L" hard temper copper water tube, ASTMB 88.
   b. Underground: Type "K" soft temper copper water tube, ASTMB 88. (No Joints Allowed), (Under Floor Slab on grade)
2. Fittings: Wrought copper and bronze pressure fittings, ANSI B16.22, or cast bronze pressure fittings, ANSI B16.18.
3. Joints: Solder joints using 95/5 solder, ASTM B 32.
4. Unions: Cast brass, ground joint type 200 psi WOG rated, FS WWU516a.

B. Valves: See attachment at the end of this section.

C. Flanges:

1. 2" Inches and Smaller: 150 pounds, forged steel, ASTM A 181, Grade I OR II, raised face, screwed, ANSI B16.5 (flat face to match flat face flanges).
2. 2-1/2" Inches and Larger: 150 Pounds, forged steel, ASTM A 191, Grade I or II, raised face, slip-on or weld neck, ANSI B16.5 (flat face to match flat face flanges).

D. Gaskets: 1116 inch thick compressed synthetic material, flat ring type, ANSI B16.21 (full face type to match flat face flanges).

E. Bolts: Carbon steel stud bolts, ASTM A 307, Grade B, ANSI B18.2.1, with two heavy semifinished hex nuts, ASTM A 307, Grade B, ANSI B18.2.2.

F. Joint Compound: TFE tape, 112 inch wide by three mil thick, Scotch brand; plastic lead seal (PLS) , John Crane; Loctite Pipe Sealant with Teflon; or Engineer approved equal.

G. Unions 2 Inches and Smaller: 150 Pound, galvanized malleable iron, ASTM A 197, ground joint, brass-to-iron seat, threaded.

2.02 SANITARY DRAIN & VENT PIPING

A. Pipe and Fittings Aboveground:

1. 1-1/2" Inches Through 10 Inches: Service weight no-hub cast iron soil pipe fittings with factory asphaltum coating, CISPI301.

B. Pipe and Fittings Underground:

1. 2" Inches Through 15 Inches: Service weight hub and spigot cast iron soil pipe and fittings with factory asphaltum coating, ASTM A 74.

C. Joints:

1. Joints in aboveground piping shall be no-hub.
2. Joints in underground piping shall be push-on.
3. No-hub joints shall be made using a neoprene sealing sleeve, a stainless steel shield, and stainless steel tightening device for each bands and stainless steel tightening device for each band, CISPI31O.
4. Compression joints in underground pipe and fittings shall be made using a neoprene gasket for push-on joining.

2.03 PLUMBING FIXTURES, TRIM AND EQUIPMENT

A. Plumbing fixtures, trim, and supports shall be as scheduled at the end of this section. ATTACHMENT "C"

2.04 PIPING HANGERS AND SUPPORTS

A. Pipe hanger and support material such as pipe, structural and rod attachments, pipe rolls, and spring hangers shall be compatible with the materials of the respective piping systems installed.

B. All similar support elements shall be of the same manufacturer.

C. Design Drawings will reflect the type and/or location of special or critical support requirements only, when required, and will be as detailed on the Design Drawings.

D. Detail, furnish, and install all hangers, supports, anchors, and guides required to properly support the various piping systems.

E. Detail, furnish, and install any miscellaneous structural members required to facilitate installation of hangers and supports.

F. Provide additional hangers and\or sway braces as required to prevent excessive vibration.

G. Adjustable steel clevis type pipe hangers are preferred rather than clamp hangers for uninsulated pipe. Where clevis type hangers are used on insulated lines, they shall have sufficient width to clear the pipe covering, including metal jacketing, if used.

H. Pipe lines shall be provided with complete hangers assemblies and shall include The pipe hanger washers, nuts, turnbuckles, rods, straps, clip angles, beam clamps, and through bolts. Any adjustable item shall have a locking device to hold it together during shock.

I. Do not provide rigid anchor points other than those indicated on Drawings.

J. The maximum spacing between pipe supports for straight runs of pipe shall be in accordance with the Plumbing Code and MSS SP-69, unless otherwise noted on the Drawings. This spacing does not apply where there are concentrated loads between supports, such as flanges and valves. Provide support in these instances in accordance with Article 3.02 Paragraph A.

K. Copper water tube shall be supported at 6'-0" intervals for piping 1-1/2 inches and smaller and at 10'-0" intervals for 2-inch size.

2.05 PIPE INSULATION

A. Fire and Smoke Hazard Ratings:

1. All insulation, adhesives, coatings, and sealers shall have fire and smoke hazard ratings, as tested by procedure complying with NFPA 255 and ASTM E84, not to exceed:
   a. Flame spread 25
   b. Smoke developed 50
   c. All components shall also be UL listed and so marked.
2. Accessories, such as adhesives, mastics, cements, tapes, and cloth for fittings shall have same component ratings as listed above. Accessories used shall be as recommended by manufacturer.
3. All products or their shipping cartons shall bear a label indicating that flame and smoke ratings do not exceed above requirements.
4. Any treatment of jackets or facings to impart flame-and-smoke safety shall be permanent. Use of water-soluble treatments is prohibited.

B. Insulation shall be fiberglass material with fine glass fibers bonded together with an inert thermosetting resin with vapor barrier and all service jacket composed of reinforced white kraft conform to the following.

1. Maximum Temperature Limit(F): 450
2. Density (lb/cu ft): 4
3. Factor (BTU-in/sq ft-hr-F) at 75F Mean: 0.23 max.

C. Products of equal quality will be acceptable from following manufacturers, subject to approval by Owner:

1. Owens-Corning;
2. Certain-teed;
3. Johns-Manville; or
4. Other approved equal.

D. All Potable water piping above floor shall be insulated I inch thick.

E. All ends and joints shall be taped and sealed.

2.06 MATERIALS FOR CLEANING AND TESTING

A. All detergents solvents, and other cleaning agents shall be compatible with the materials of fabrication of the systems, in which they are used. They shall not adversely affect the materials or mechanisms in the systems and they shall be acceptable to equipment manufacturers. All detergents, solvents, and other cleaning agents shall also be compatible with the process streams to be handled by the system in which they are used.

B. Blinds, gaskets, bolts, etc., used in isolating segments of systems shall conform to the specification for adjacent materials.

C. Furnish all labor, tools, and equipment required for pressure testing piping systems.

PART 3 - EXECUTION

3.01 GENERAL

A. Routing: Piping Drawings are generally to scale but piping shall be placed by calculated dimensions rather than dimensions scaled from Drawings. Route piping by shortest run consistent with good installation practice, clearance requirements, and expansion and flexibility provisions. Arrange piping to facilitate support of piping and ease of removal for inspection or servicing. Maintenance areas shall be clear of piping. Cut and hang pipe to align freely with flanges and fittings.

3.02 FABRICATION

A. Make all changes in size and direction of piping with fittings. Do not use miter fittings, face of flush bushings, close nipples, or street elbows, except as shown on Drawings. Use eccentric

reducing fittings or eccentric reducing couplings where required by Contract Documents, where required to prevent pocketing of liquid or non-condensables or as required to maintain a level bottom of piping elevation when using pipe support bridges which are all located at same elevation.

B. Use clean cut screwed thread with no stripping or burrs from cutting or threading. Dies shall be new, sharp, and properly designed for piping material. Clean threads on pipe and fittings thoroughly of cuttings, dirt, oil, or other foreign matter immediately before erection. Liberally coat male threads with thread lubricant or TFE thread tape and make up piping sufficiently for threads to seize. Do not mar or damage pipe and fitting surfaces. Do not use Permatex, lampwick, cord, wool, or any other similar material for thread sealant.

C. Locate valves, and other equipment which must be observed, adjusted, or serviced during operation, so that they are conveniently accessible.

D. Provide flanges or unions at all [mal connections so that equipment served may be removed without disturbing piping.

E. Install piping to coils, pumps, and other equipment at full size indicated on Drawings with size reductions installed at equipment.

F. Space pipe supports and arrange reducers to allow the system to be drained at low points and vented at high points. Pockets shall be avoided in lines.

3.03 SLEEVES, PLATES AND ESCUTCHEONS

A. Provide penetrations through walls, partitions, beams, and slabs with sleeves large enough to adequately accommodate pipe plus any insulation and thermal movement. Cut, patch, and install sleeves and inserts at location indicated on drawings.

B. Sleeves in walls and elevated slabs shall be standard weight carbon steel pipe having minimum internal diameter 1" inches larger than outside diameter of pipe left bare, or 1" inches larger than outside diameter of pipe insulation, unless otherwise indicated. Sleeves through slabs on grade or walls below grade shall be galvanized carbon steel or cast iron, sized as outlined above. Wall sleeves shall be flush on both sides of wall, and floor sleeves flush on ceiling side and extend 1 sleeves shall be flush on both sides of wall, and floor sleeves flush on ceiling side and extend a inch above floor, except where otherwise indicated or necessary to suit location and piping function.

C. Set sleeves in place before pouring concrete or securely fasten and grout sleeves with cement. Set wall sleeves as wall is constructed. Core drill sleeve holes through concrete floors or masonry walls where sleeves are inadvertently omitted. Do not use jackhammer or pavement breaker unless approved by Owner and engineer.

D. Fill annular space between pipe and sleeve through interior walls and elevated floor slabs with mineral wool or fiberglass.

E. Pack annular space between pipe and sleeves through exterior walls, walls below grade, and ground floor slabs with oakum, seal with lead wool and watertight mastic or asphalt, or linkseal units.

F. Pack annular space between pipe and sleeve through fire walls with mineral wool and close off ends with metal cap or plate.

G. Install pipe sleeves where indicated on Drawings to accommodate passage of certain piping services under foundations and elsewhere. Install pipe sleeves of material noted. Place a steel plate cut to closely fit pipe at each end of sleeve before back-filling.

H. Provide chrome-plated escutcheon where pipes pass through walls or floors in finished areas. Provide nickel plated steel plate where pipes pass through walls or floors in unfinished areas.

3.04 JOINTS BETWEEN DISSIMILAR METALS

A. Make joints between ferrous and non-ferrous screwed piping and equipment with insulating unions as manufactured by Capital Manufacturing Company, EPCO Sales, Inc., equal.

B. Make joints between ferrous and non-ferrous flanged piping and equipment with EPCO dielectric flange unions, EPCO or Duriron insulating gaskets, sleeves and washers, or equal.

C. Entire insulating joint including dielectric material shall be suitable to withstand temperature, pressure and other operating characteristics of service for which it is used.

3.05 UNDERGROUND PIPE INSTALLATION

A. General: Lay, align, anchor, and test pipe and make up joints. Perform excavating, cleaning, laying, jointing, and backfilling as concurrently as possible to maintain uniform installation. Do not leave un-jointed piping in trench overnight. Backfill and compact trench as pipeline installation progresses. Do not backfill joints until system has been tested and accepted.

B. Handling: Replacing or repair damaged materials to Condition equal to new material.

C. Alignment:

1. Install piping to conform accurately to lines and grades indicated on Drawings or in Specifications. Do not drop or block up pipe to attain required grade. Remove and relay pipe if grade deviates by 1/4 inch or more from grade shown on Drawings or required.
2. Slope 3 inches diameter and larger gravity drain lines down in direction of flow at minimum 1/8 inch per foot unless indicated otherwise.
3. Slope gravity drain lines smaller than 3 inches diameter down in direction of flow at minimum 1/4 inch per foot unless indicated otherwise.

D. Pipe Crossings: Lay lower pipe, backfill with crushed stone, gravel, or concrete as directed and thoroughly compact to level of upper pipe. Maintain minimum 6 inches clearance between bells of upper and lower pipes.

3.06 WELDING

A. All welding of carbon steel shall be by one of arc welding processes including, but not limited to following:

1. Manual shielded metal arc;

2. Manual shielded metal arc with Tig root pass;
3. Tungsten inert gas (Tig); or
4. Metal inert gas (Mig).

B. Entirely cover threads with seal weld where seal welding of threaded joints is performed. Make up threaded joints to be seal welded without any thread compound.

C. Preheat and post heat welds when required in accordance with welding procedure.

D. Remove and repair defects in welds requiring repair in accordance with ANSI b31.3 as applicable. Drain piping with weld leaks discovered during hydrostatic test to level below leak before weld repair. Release pressure on piping with weld leaks discovered during pneumatic test before repairing weld.

3.07 BRAZING

A. Use non-ferrous metal or alloy filler metal having melting point above 800°F and below that of the metal being joined. Use filler metal and flux recommended by manufacturer for metals being joined in accordance with approved procedure.

3.08 SOLDERING

A. Perform soldering similar to brazing above, except use solder alloy that melts at a temperature below 800°F. Clean outside end of pipe and the inside cup of fitting with steel wool or sand cloth. Apply flux evenly but sparingly, until surfaces to be joined are completely covered. Use non-corrosive paste type flux recommended by manufacturer for solder alloy being used. Remove all excess solder with small brush while it is still in plastic state, but leave filler around cup of fitting as it cools. Unless indicated otherwise, for solder use Alloy 95-5 (tin/antimony) for temperatures up to 250°F and pressures up to 150 psig for 4 inches and smaller.

3.09 PAINTING

A. Painting of piping, valves, equipment, devices, and supports shall be as specified in Section 09900.

B. Paint all underground parts of valve boxes, valves, and metal anchor devices with Koppers Company, Inc., "Bitumastic 50" or approved equal. Paint inside and outside of valve boxes.

3.10 FIXTURE INSTALLATION

A. Adequately support all fixtures.

B. Connect supply and/or drain pipes to walls and not to floors. Exposed junctions to walls shall have chromium plated escutcheons neatly and firmly secured in place.

C. Exposed piping and metal work in connection with fixtures shall be chromium plated brass.

D. Provide stop valves for each plumbing fixture.

E. Install chrome plated pipe and fittings with a strap wrench. Any marred pipe or fitting shall be removed and replaced at no additional cost to Owner.

F. Caulk junction of fixtures with walls all around with non-shrink caulking compound.

3.11 INSULATION INSTALLATION

A. Install insulation and finishes according to manufacturer's recommendations. Butt joints tightly together and securely attach insulation materials. Clean and dry surfaces before insulation is applied. Cut and fit insulation around irregular surfaces, and apply covering tight and smooth.

B. Use insulation with continuous unbroken vapor seal on all cold surfaces where vapor barrier jackets are used. Insulate and vapor seal hangers, supports, anchors, or other items that are secured directly to cold surfaces to prevent condensation.

C. Protect insulation from physical damage at points of support where insulation must carry load imposed by support. Coordinate this requirement with types of hanger and support used.

D. Do not use partial lengths of any type insulation where full length will fit.

E. Apply all insulation, adhesives, and finishing materials in accordance with manufacturer's recommendations or instructions.

F. Unless otherwise noted, insulate all flanges and valves and conform to the same type and thickness as the adjacent pipe.

G. Apply I-inch through 2-inch thick insulation in a single layer broken joint method with all joints tightly butted together.

H. Fill all voids with broken insulation of the same material being used or with insulating cement.

I. Fitting insulation shall conform to the same type and thickness and shall be applied in the same manner as prescribed for adjacent pipe unless otherwise specified.

J. All insulation shall fit the surface of the pipe snugly and shall be fabricated or molded so as to leave not more than 1/8 inch void between the surface to be insulated and the insulation itself. All insulation joints shall be close fitting.

K. Flash all metal protrusions through hot insulation to prevent entrance of water.

L. For all metal protrusions through cold insulation, provide vapor stop.

3.12 FIXTURE INSPECTION AND TESTING

A. Visually inspect each fixture before and after installation for defects, proper operation, and stability of support.

B. Test each fixture for soundness, stability of support, and satisfactory operation.

C. Piping at fixtures shall be absolutely tight under test.

3.13 METHODS FOR CLEANING AND TESTING

A. Systems specified in this Section shall be cleaned and tested in accordance with the index in Attachment A:

3.14 CLEANING

A. General:

1. Provide and install all necessary temporary connections, strainers and other equipment to thoroughly clean the piping systems before start-up. Dispose of all cleaning agents and remove all temporary connections and strainers after cleaning is complete.
2. Piping should be cleaned just prior to installation and/or plant start-up when possible. All cleaned piping material shall be protected against contamination by sealing all open ends with clean plastic sheet or metal foil.
3. All cleaning procedures shall be subject to the approval of the Owner or his designated representative and will be completed to his satisfaction.

B. Cleaning Methods

1. Cleaning Method (Sanitary Drains)
   a. Prior to erection:
      i) Hammer, brush, etc., to loosen sand, dirt, scale, or other contaminants when necessary
      ii) Blow with air, or hose with clean water, and visually inspect for contaminants.
      iii) On pipes stored before erection, dry and seal the ends to prevent contamination during storage.
   b. After erection thoroughly flush the system with clean water to remove all foreign material.
2. Cleaning Method (Potable Water)
   a. Prior to erection:
      i) Surface clean as required.
      ii) Blow with air, or hose with potable water and visually inspect for contaminants.
   b. After erection:
      i) Flush system thoroughly with potable water for sufficient time to ensure thorough cleaning.
      ii) Flush system prior to making connection to interior potable water system.
      iii) After cleaning, potable water systems shall be disinfected as described below.

C. Disinfection of Potable Water Systems:

1. Provide nipples and valves as required to introduce disinfectant and water, to vent air and to drain the solution, whether or not these connections are shown on the Drawings.
2. Clean the system as specified in the Testing and Cleaning Index in Article 3.13.
3. Fill the system uniformly with a disinfection solution of 50 ppm available chlorine. The disinfectant shall be retained no less than 24 hours. As an alternative, a solution of 300 ppm

held for three hours is also acceptable. After the holding period, a test for residual chlorine shall be made. If none is found, the system shall be drained and the disinfection procedure repeated. When a positive residual chlorine test is accomplished, the system shall be flushed with potable water and put into operation. The methods used for disinfection should be in accordance with the latest published procedure of the AWWA C601.

4. For very minor jobs, such as replacement of a single fitting or repair of a valve, the item being installed can be precleaned and then disinfected by immersing it in a solution of 300 ppm of chlorine for one hour.

3.15 TESTING

A. General:

1. Equipment such as vessels, heat exchangers, pumps, compressors, and the like shall be isolated during testing of the piping system. Retest of equipment which has been shop tested is not required unless the equipment has been damaged or disassembled during shipment or erection. The test pressure for such a retest shall not exceed the shop test pressure and the Owner shall determine whether or not a retest is required. Inclusion of the equipment in the testing of piping systems shall not be done without' approval of the Owner.

2. Test pressure shall be as defined in the index in Article 3.13. Final test pressure for each test shall be maintained for a sufficient length of time to facilitate a complete inspection of all joints and connections, but no less than that specified by the applicable testing procedure. When it is necessary, for practicality, to include a vessel or other equipment, the test pressure shall not exceed the allowable cold limit of the equipment.

3. Detected leaks shall be repaired. Piping systems shall be retested if revisions or repairs are made in piping or pressure equipment.

4. Since the risk of failure, with the attendant possibility of injury, is appreciably greater during testing, all safety measures required by codes or ordinances applicable to the situation shall be taken.

5. Equipment or piping to be pressure tested shall not be insulated, covered, painted or concealed prior to test. Compression joint underground piping may be backfilled prior to pressure test except that joints shall remain exposed until after the test. Tie rods, clamps, etc., shall be in place and fastened.

6. These tests shall not be used to establish pressure ratings.

7. Protect all piping and equipment against over-pressure collapse from vacuum and hydraulic shock during the filling, testing, and draining procedures. Seats of iron valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve. Pressure tests against other closed valves shall not exceed the manufacturer's cold pressure limit. Note that where significant differences in elevation exist, there is a risk of over-pressure in the lower portions of the system in order to attain test pressure in the upper portion of the system.

8. Apply test pressure only after the system and test medium are at approximately the same temperature, preferably not less than 60°F. Note that some applicable codes require testing above a specified minimum temperature. Water temperature shall not exceed 125°F.

9. Test, including the inspection of all joints, shall be made to the satisfaction of the Owner's Representative. Following the completion and approval of the test, restore all components of

the system to normal operating condition. This includes removing the temporary provisions installed for the test.

B. Preparatory Work:

1. Remove from the system all pumps, turbines, traps, shock arrestors, expansion joints, instruments, control valves, safety valves, rupture discs, filters, orifice plates, etc., which might be damaged by the test, or are designated by the Owner's Representative. Also remove all items such as orifice plates which might trap air in a system to be hydrostatically tested. Disconnect all instrument supplies.
2. Open but do not backseat all valves including bypass valves. Lines containing check valves shall have the source of test pressure on the upstream side.
3. Clean systems prior to testing.
4. Systems may be separated into sub-systems for testing if such action will expedite or simplify the testing.
5. During hydrostatic testing of lines with spring hangers designed for fluids lighter than water, travel stops or locks shall be installed on the hangers, or temporary solid rod supports must be provided during the entire time the line is filled with water to support its additional weight and prevent overloading the springs. Also provide temporary supports where required to prevent over-stressing supports other than spring hangers. When tests are completed, remove temporary supports, locks, stops, etc., and set supports for their cold load.

C. Testing Methods:

1. Test Procedure Tl (Hydrostatic Test)
   a. Only filtered water shall be used as test media.
   b. No hydrostatic testing shall be done when the ambient temperature is 40°F or lower unless special cold weather provisions are approved by the Owner.
   c. Provide vents and drains as required.
   d. All lines shall be thoroughly cleaned before testing.
   e. Items which are not to be subjected to the hydrostatic test shall be either removed or blanked off. Short sections of piping removed to permit the installation of blinds or blanks shall be tested separately.
   f. The test pump hookup for hydrostatic test shall permit applying the pressure gradually under close control. A valve shall be provided for isolating the piping from the pressure source during the test period. They system should be filled with water through a low connection point, case being taken that air is completely vented so that there are not air pockets remaining. The pressure shall be applied gradually and held at the specified value for the time required to visually check each weld, connection, joint, flange, etc., but not less than a minimum of one hour. Test readings may be taken at the lowest point of the line or system of lines with static head added to the minimum hydrostatic test pressure. Care shall be taken to ensure that at not point a dangerous over-pressure is experienced.
   g. The hydrostatic test shall be considered satisfactory if no visible leakage, cracks or other signs of distress are discovered on the piping or at any joints. There is no requirement for minimum pressure drop during the test period; however, the cause of any pressure loss other than that due to temperature change or similar reasons shall be justified to the satisfaction of the Owner's Representative.

h. Minor leaks in screwed or flanged joints may be repaired without retesting subject to the approval of the Owner's Representative.

i. Any welded joint found leaking shall be repaired in accordance with the original welding procedure and completely retested.

j. After completion of hydrostatic testing, the system shall be completely drained at all low points in such a way as to accomplish thorough flushing of the system. Test blinds, temporary supports, test equipment, etc., shall be removed, and any valves, orifice plates, short sections of piping, miscellaneous in-line equipment or instruments that were removed prior to testing shall be re-installed and the line left ready for service. New gaskets shall be used when re-installing flanged items.

k. Care shall be taken to ensure the complete removal of all water from the line or system after testing. If there is any danger of contamination or freezing, blowing out the fluid with air is necessary.

2. Test Procedure T5 (Leak Test for Interior Sanitary Drainage Systems):

a. Make tests as may be required by local plumbing authority, in addition to those specified, at no additional cost to the Owner.

b. Make tests on concealed piping before piping is closed-in.

c. Make air test by attaching air compressor or testing apparatus to suitable opening, close all other inlets and outlets to system and force air into system until there is uniform gauge pressure of 5 psi or sufficient to balance a column of mercury 10 inches in height. Hold pressure without introduction of additional air for a period of at least 15 minutes. Test every joint with soap suds while system is under air pressure.

d. Make water test in lieu of air test of soil and waste piping. Test piping either in its entirety or in sections. Do not make water test during cold weather until temporary heat is available. Close all openings except highest one and fill system with water to point of overflow, if test is applied to entire system. Close all openings except highest one in section under test and fill section to point of overflow, if system is tested in sections.

e. Test at least the upper 10 feet of next preceding so no joint or pipe in building (except the uppermost 10 feet of system) is submitted to test of less than 10-foot head of water, if system is tested in sections. Leave water in system or in portion under test for at least 15 minutes before inspection starts. Inspect joints for visible leakage.

f. Make final test of system after all plumbing fixtures have been set and their traps filled with water. Introduce into entire system pungent, thick smoke. Close openings when smoke appears at stack openings on roof. Build up pressure equivalent to I inch water column and maintain for 15 minutes before starting inspection.

g. Take apart, clean, and remake any joints not tight under test.

h. Furnish gauges, pumps, compressors, and instruments necessary for above tests.

3.16 INSPECTIONS

A. Inspections as required by local building authorities shall be held and certificates of inspection delivered to the Owner.

B. The Owner's Representative reserves the right to make any inspections. Give the Owner's Representative free access to his work, and whenever requested, shall furnish him with full information as to progress of the work and its various parts at place of fabrication or on the job site. Such inspection shall not relieve the Contractor from full responsibility for the quality and correctness of his work.

C. If the Specification, Owner's Representative's instructions, ordinances, law, or any other public authority requires any special tests or approval, the Contractor shall give the Owner's Representative timely notice of his readiness for inspection. If the inspection is by an authority other than the Owner's Representative, the Owner's Representative shall be informed as to the place and date fixed for such inspections.

3.17 ATTACHMENTS

A. The following Attachments are part of this Section:

1. Cleaning and Testing Index "A"
2. Valve List
3. Plumbing fixtures, drains, equipment "C"

END OF SECTION 15400

ATTACHMENT A – CLEANING AND TESTING INDEX				
Symbol	Service	Test	Test Pressure	Test Procedure
PW	Potable Water	Hydrostatic	150psig	T1
PWH	PW Hot	Hydrostatic	150 psig	T1
SSD	Sanitary Drain	Hydrostatic	10 ft H2O	T5
SV	Sanitary Vent	Hydrostatic	10 ft H2O	T5

ATTACHMENT B – VALVES

BALL VALVES

Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
Manufacturers: Subject to compliance with requirements
- Hammond Valve.
- Jamesbury; a subsidiary of Metso Automation.
- Legend Valve.
- Marwin Valve; a division of Richards Industries.
- Milwaukee Valve Company.

Description:
- Standard: MSS SP-110.
- SWP Rating: 150 psig (1035 kPa).
- CWP Rating: 600 psig (4140 kPa).
- Body Design: Two piece.
- Body Material: Forged brass.
- Ends: Threaded.
- Seats: PTFE or TFE.
- Stem: Brass.
- Ball: Chrome-plated brass.
- Port: Regular.

Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
Manufacturers: Subject to compliance with requirements
- American Valve, Inc.
- Conbraco Industries, Inc.; Apollo Valves.
- Crane Co.; Crane Valve Group; Crane Valves.
- Hammond Valve.
- Lance Valves; a division of Advanced Thermal Systems, Inc.
- Legend Valve.
- Milwaukee Valve Company.
- NIBCO INC.
- Red-White Valve Corporation.
- Watts Regulator Co.; a division of Watts Water Technologies, Inc.

Description:
- Standard: MSS SP-110.
- SWP Rating: 150 psig (1035 kPa).
- CWP Rating: 600 psig (4140 kPa).
- Body Design: Two piece.
- Body Material: Bronze.
- Ends: Threaded.
- Seats: PTFE or TFE.
- Stem: Bronze.
- Ball: Chrome-plated brass.
- Port: Full.

Class 125, Bronze Swing Check Valves with Bronze Disc

Manufacturers: Subject to compliance with requirements,

- American Valve, Inc.
- Crane Co.; Crane Valve Group; Crane Valves.
- Crane Co.; Crane Valve Group; Jenkins Valves.
- Crane Co.; Crane Valve Group; Stockham Division.
- Hammond Valve.
- Kitz Corporation.
- Milwaukee Valve Company.
- NIBCO INC.
- Powell Valves.
- Red-White Valve Corporation.
- Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- Zy-Tech Global Industries, Inc.

Description:

- Standard: MSS SP-80, Type 3.
- CWP Rating: 200 psig (1380 kPa).
- Body Design: Horizontal flow.
- Body Material: ASTM B 62, bronze.
- Ends: Threaded.
- Disc: Bronze.

ATTACHMENT C - PLUMBING FIXTURES, DRAINS, EQUIPMENT

Plumbing Fixtures

WC-1 Water closet, floor mounted, elongated bowl, siphon jet, white vitreous china, chrome plated flush valve, 1-1/2" top inlet, 1.1-1.6 gallons per flush, bolt caps, 12" rough-in, solid plastic seat with check hinge.

L-1 Lavatory, wall mounted, white vitreous china, nominal 21"X18", chrome plated brass single lever faucet, 3/8" hot & cold water supplies, cross handled stops, 1-1/2" X 1-1/2" 20 gage chrome plated brass p-trap, drilled for concealed arm carrier.

EW Portable eyewash, with heated 16 gallon polyethelene water storage tank, , 120V-1,000 watt heater, submersible thermostat to maintain 70°F water temperature, ABS plastic eyewash heads, 0.4 GPM flow rate, supplied with 1-bottle of water preservative, pull-down activation arm, integral handles on top and sides, jacket shall be insulated, power cord.

Hb Hose bibb, 3/4" brass or bronze with non-removable vacuum breaker, metal hand wheel, hose threads.

Plumbing Equipment

EWH-701 Electric water heater, see schedule on DWG P0-001 for technical data.

Drains, Cleanouts and Accessories

FD-1 3" Floor drain, 6"diameter nickel bronze grate, cast iron body, adjustable head, flashing flange, trap primer connection.

FD-2 3" Floor drain, cast iron body, cast iron tractor grate, sediment busket, flashing collar, deep seal p-trap.

FCO Floor cleanout, cast iron body, bronze closure plug, size per pipe size on drawings.

CO End of line cleanout, cast iron body with brass cleanout plug.

WCO Wall cleanout, cast iron cleanout tee with brass cleanout plug, round stainless steel access cover.

YCO Yard cleanout, cast iron body, brass cleanout plug, set in concrete pad for exterior use.

TRAP PRIMER : Automatic primer that discharges a prime of water with a pressure drop in the water supply.

SECTION 15765
UNIT HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Provide equipment, materials, accessories, and labor necessary to install electric heaters of the size, type, capacity, and characteristics shown on the Drawings and described in these Specifications.

1.02 SUMMARY

A. Section includes:

1. Propeller unit heaters with hot-water or electric-resistance heating coils, as scheduled on the plans.
2. Electric cabinet heaters with centrifugal fans and electric-resistance heating coils.

1.03 SUBMITTALS

A. Submit product data in accordance with Section 15050.

B. Submit:

1. Catalog cut sheets
2. Materials of construction
3. Paint, coating, finish, and color information
4. Heating capacity
5. Electrical data
6. Installation and maintenance instructions
7. Spare parts list

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. Heaters shall bear the UL label.

PART 2 - PRODUCTS

2.01 UNIT HEATERS

A. Provide items as scheduled on the Drawings.

B. Acceptable manufacturers:

1. Qmark
2. Markel
3. Berko

2.02 ELECTRICAL INFORMATION

A. Refer to electrical drawings for correct voltage and phase.

B. Provide all electrical components in accordance with Division 16.

C. Provide with control transformers for automatic controls with electric power characteristics as required for automatic.

D. Provide each unit with single point power connection. Power for all unit electric components including motors, heaters, control actuators and control transformers shall be wired from this single point of power connection.

PART 3 - EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturer's recommendations.

B. Provide controls and interlocks to control and interlock as described in Section 15950.

END OF SECTION 15765

SECTION 15885
DRY MEDIA ODOR CONTROL SYSTEM

PART 1 - GENERAL

1.01 WORK INCLUDED

A. This Specification defines the requirements for a modular engineered dry media chemical scrubber odor control system. Provide materials, labor, and accessories necessary to completely fabricate and install the dry media odor control system shown on the Contract Documents.

B. The Contractor shall provide all equipment and work indicated below unless otherwise noted and any additional work to produce a completely finished job as required by the Engineer.

1.02 SUBMITTALS

A. Submit shop drawings and product data in accordance with the General Conditions of the Contract.

B. Submit the following:

1. Expected media life at specified airflow volumes and hydrogen sulfide (H2S), methyl mercaptans and dimethyl disulfide removal rates.
2. Dimensioned drawings, including bill of materials. Materials of construction, operating and dry weights, structural reactions.
3. Installation instructions.
4. Air flow and H2S, methyl mercaptans and dimethyl disulfide removal performance data for the equipment being provided.
5. Alternative arrangement if provided at no cost to the City.
6. Modular Odor Control Equipment
   a. Overall Dimensions.
   b. Net Weight.
   c. Operating Weight.
   d. Construction Materials.
7. Engineered Dry Media
   a. Name of Manufacturer.
   b. Type of Material.
   c. Quantity.
   d. Odor absorption performance of the media.
   e. Media Disposal.
   f. Material Safety Data Sheet (MSDS).
8. Test Results
   a. Submit test data on an actual prototype dry media odor control scrubber to verify system performance.
   b. Such testing shall have been conducted in a representative section of the full scale scrubber, at full scale media bed depth, and equivalent hydrogen sulfide loads.

c. Hydrogen sulfide, methyl mercaptans and dimethyl disulfide load rate to the test system shall, as a minimum, represent full scale operation at 20 ppmv for one hour.

d. Test data shall include:

i) Media temperature.

ii) Air discharge temperature.

iii) Combined hydrogen sulfide, methyl mercaptans, dimethyl disulfide and air volume flow rate at scrubber inlet throughout the test run.

iv) Continuous recording of scrubber discharge hydrogen sulfide concentration, measured to +/- 5 ppb accuracy.

v) Media bed pressure drop at specified air volume flow rate.

vi) Test results shall demonstrate a continuous air discharge containing less that 0.1 ppmv hydrogen concentration throughout the test.

vii) Tests shall verify that the proposed scrubber system will perform, as specified, with media at a start-up temperature as low as -40° F, without the requirement for supplemental heating.

1.03 OPERATION AND MAINTENANCE

A. Submit operation and maintenance data in accordance with the General Conditions of the Contract.

1.04 WARRANTY

A. Warrant in writing against defective or deficient equipment and workmanship in accordance with General Conditions of the Contract and as noted below.

B. Warrant, in writing, that the interior surfaces of all components and the mounting fasteners will withstand corrosive environment for five years.

C. Warrant, in writing, that each scrubber system will provide, in continuous duty, the performance outlined below.

1. The odor control system media shall be capable of removing not less than 99.5% odorous gases from sewage tunnel at an airflow rate of 6,000 cfm.

2. Media bed pressure drop shall not exceed 1.30-inches w.g. at 250 fpm of air velocity for a module measuring 24 x 12 x 12.

1.05 ANALYTICAL SERVICES

A. The manufacturer shall be able to provide in-house lab analysis of the equipment media predicting the remaining life cycle of the media. Such service shall be provided at the manufacturer's expense.

B. Such service shall be provided at the manufacturer's expense for a period of at least ten years.

C. Manufacturer or manufacturer's representative shall provide a minimum of one (1) eight hour day for startup and training on all units.

PART 2 - PRODUCT

2.01 ACCEPTABLE MANUFACTURERS

A. Acceptable odor control system shall be a Modular Chemical Scrubber, double walled side access system (see schedule and notes on plans for complete model number) as manufactured by Purafil, Inc..

B. Design has been based on Purafil with dry chemical media as manufactured by Purafil, Inc.

C. Only those manufacturers who manufacture and furnish media, which meets the requirements of this specification, shall be accepted.

D. The manufacturer shall be a single source provider of equipment, media and testing services and be certified to ISO-9001 standards. ISO certificate must be submitted at time of bid.

E. The manufacturer shall have local, factory-trained representatives.

F. The manufacturer shall also manufacture media in their own facility to ISO-9001:2008 standards. Written proof that chemicals and a disc capable of producing media at their headquarters must be provided. Re-sellers of equipment and media will not be accepted.

2.02 SIDE ACCESS HOUSING CONSTRUCTION

A. Housing shall be constructed of aluminum double-wall insulated casing. The unit shall be manufactured with monolithic panels for system rigidity and gasketed side access doors for servicing all components. Doors shall be on both sides of the unit. The unit shall feature exterior-mounted adjustable compression latches and handles. Closed cell gasketing shall be provided to prevent air leakage around doors and between the doors and filters.

B. All joints shall be sealed with adhesive sealant or approved equal. For outdoor operation, weatherproof pan with drip edge will be provided.

C. The scrubber housing shall be provided with base support.

D. The active scrubber housing shall be designed to facilitate standard fan and motor maintenance contained within the unit.

E. Door seals shall be self adhesive and designed for replacement.

F. Aluminum nameplate shall be provided, permanently attached to the unit. Nameplate shall be engraved with the scrubber type, order number and serial number.

G. The inlet shall contain a mist eliminator prior to the media beds and before the blower. The passive system shall also contain a mist eliminator prior to the media bed.

H. A clearance of at least thirty (30") is required to access the blower and media modules.

I. For all filtration sections, extruded aluminum filter slide tracks shall be provided to allow easy access for servicing of filters.

J. The manufacturer shall provide a differential pressure gauge and pressure taps to measure pressure drop throughout the unit.

K. Mist Eliminator filter tracks shall include nylon pile seal to mate with the sealing face of all filters.

L. The Side Access System includes a downward-slanted extruded aluminum filter slide tracks that support modular media containment devices via a corresponding angled notch in the module's frame to create self-sealing pressure and prevent air bypass.

M. Sound Insulation shall be provided at around the blower door for decibel reduction. Sound Pressure Level: 45 dBA at 50 feet rating according to ARI 270.

N. Rain or acoustical (see plans) louver shall be provided on outlet of the unit and shall extend the duration of the back side of the unit. Wind-Driven Rain Performance: Not less than 95 percent effectiveness when subjected to a rainfall rate of 8 inches per hour and a wind speed of 50 mph at a core-area intake velocity of 400 fpm.

O. Mist eliminator shall be mounted at inlet of the system, centered.

P. An inlet transition shall be provided to the Contractor's specified ductwork.

2.03 BLOWER

A. The Blower shall be located in the housing after the 4th stage of air cleaning. It shall have a backward curved, centrifugal, Fiberglass Reinforced Plastic (FRP) wheel and belt driven by a 230/460 volts 3 phase 60 Hz motor Blower motor.

B. Blower shall include sound attenuation gasketing.

2.04 CHEMICAL MEDIA SECTIONS

A. The housing shall contain four (4) chemical media sections as recommended by Purafil chemical analysis software or chemical analysis equal and designed to accommodate modular media containment devices, utilizing filter tracks.

B. The module shall have a nominal size of 24.0" wide x 12.0" high x 12.0" deep (610 x 305 x 305 mm) in direction of airflow with a medium bed depth of 3.0" (76.2 mm) and contain 1.0 ft3 (0.028 m3) of Purafil engineered media. The module shall be completely recyclable and/or disposable and constructed of 0.125" (3.175 mm) recyclable plastic.

C. The module shall be factory-filled with Purafil engineered and manufactured patented chemical media. The module must be factory-filled and vibrated to eliminate bypass.

D. Pressure drop at maximum air velocity through each chemical media section shall not exceed 1.30 iwg (324 Pa) for a module measuring 24 x 12 x 12 inches/610 x 305 x 305 mm (width x height x depth). Maximum air velocity through chemical media section shall be 250 ft/min (1.27 m/sec) for a module measuring 24 x 12 x 12 inches/610 x 305 x 305 mm.

E. The module with engineered, dry-chemical media shall be UL Classified Class 2. Manufacturer shall provide documentation.

F. Single-source manufacturer must provide in-house laboratory media life analysis at no-charge for as long as their media product is in operation.

G. System shall be designed for 250 ft/min.

2.05 FILTERS

A. The mist eliminator shall be designed to remove 99% of water vapor (>4 micron diameter). The mist eliminator shall be located at the air inlet. Water collected shall drain into a collector pan and into the drain system. The drain system, complete with loop seal (P-trap), is required to overcome the vacuum created by the downstream blower.

B. The mist eliminator pad shall be 2 inches in thickness at a minimum and shall consist of six layers of Kimre 1696 general purpose polypropylene mesh or approved equal.

C. Hinged access doors with gaskets shall allow for the mist eliminator to be removed, cleaned, and/or replaced.

D. Pressure taps and gages shall be installed to permit a local read out of the mist eliminator pressure drop.

E. Mist Eliminator shall be centered at inlet and designed to work at 500ft/min face velocity.

F. The mist eliminator shall have a blind flange for connection to incoming piping network.

G. An inlet transition shall be provided to the Contractor's specified ductwork.

2.06 CHEMICAL MEDIA

A. The unit shall contain four passes of Odormix SP as manufactured by Purafil, Inc.

B. The Odormix SP Media shall consist of an equal mix (by volume) of Purafil ESD's Odoroxidant SP Media and Odorkol

C. Media: Odoroxidant SP Media shall be manufactured of generally spherical, porous pellets formed from a combination of powdered activated alumina and other binders, suitably impregnated with potassium permanganate to provide optimum adsorption, absorption, and oxidation of a wide variety of gaseous contaminants. The potassium permanganate shall be applied during pellet formation, such as the impregnant is uniformly distributed throughout the pellet volume and is totally available for reaction. Odorkol Media shall be a premium grade, activated carbon with a high surface area available for adsorption.

D. Odormix SP Media shall have the following physical properties:

1. Odoroxidant SP Media
2. Moisture content: 35% maximum
3. Average crush strength: 35% minimum - 70% maximum
4. Average abrasion: 4.5% maximum
5. Bulk density: 50 lbs/ft3 (0.8 g/cc) +5%

6. Nominal pellet diameter: 1/16" (1.587mm)
7. Sodium permanganate content: 12% minimum

E. Odorkol Media

1. Moisture content: 5.0% maximum
2. CTC: 55 minimum
3. Base material: activated carbon
4. Bulk density: 30-32 lbs/ft3 (0.48-0.51 g/cc) +5%

F. Odormix SP Media shall be UL Classified Class 1.

G. Purafil media only will be accepted due to the high level of capacity. No equals will be accepted.

H. Only UL certified media will be accepted in this aluminum vessel with companies that contain additional product liability on their systems. Companies lacking this liability and UL certification will not be accepted.

I. All media must have proof that is made and produced in the United States for additional verification of product performance.

2.07 ACCESSORIES

A. Pressure Gage: Magnehelic type pressure gages shall be included with the scrubber to permit local read-out of pressure drop through the mist eliminator and at each media stage. Pressure gages shall be prepiped at the factory with stainless steel tubing and housed in aluminum boxes for weather protection.

B. Provide a minimum of 4-inches tall structural aluminum skid for installing the scrubber on the top of the concrete slab.

C. Provide a rain louver constructed of heavy gage aluminum and stainless steel bird screen.

2.08 MOTOR STARTER AND CONTROL PANEL (ACTIVE UNITS ONLY)

A. NEMA 4X, 316 stainless steel enclosure

B. Motor starter: FVNR, ATL, with overload heaters, NEMA sized for 30h.p. 460 VAC motor.

C. Control power transformer, 460/120 VAC, with fused primary and secondary.

D. Main circuit breaker, magnetic, with front-panel operating handle.

E. Operator interface and display:

1. "Hand-Off-Auto" selector switch
2. Indicating lamps (all lamps are push-to-test style):
3. "Fan Off"

4. "Fan Running"
5. Note: customer to supply 460 VAC power.
6. Contacts available for Photohelic gauge input and indicator light.
7. Control panel shipped loose to be installed in electric control room.

F. Remote monitoring Interface - provide the following dry contacts for interfacing remotely to the Plant Control system:

1. Common Trouble (Differential pressure or any other monitoring function)
2. Motor Running Indication (from motor Starter)
3. Motor Starter Common Trouble (overload or any interlocks provided)
4. Motor Starter Hand-OFF-Auto Selector Switch - Auto Position Indication (add a separate NO contact to AUTO Position of the selector switch)
5. Remote Start/Stop Output from Plant Control System (Powered by the Starter - when H-O-A is in Auto position closing this output contact will energize the motor starter)

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Inspect all equipment immediately upon delivery to site.

B. Do not install damaged equipment until repairs have been made in accordance with manufacturer's written instructions and approved by the Engineer. Damaged items shall be sent to factory for repair or replacement, unless otherwise approved by the Engineer.

C. Protect equipment in accordance with Specification Section 01611.

3.02 INSTALLATION

A. Install odor control systems and pieces of equipment in accordance with the manufacturer's written instructions.

B. Install scrubber on the factory furnished structural aluminum skid on concrete slab as shown on the Drawings. Anchor the system to the concrete slab with minimum 4-inch embedment.

C. Furnish the services of qualified factory representatives of the odor control system manufacturer for inspection, start-up, and instruction of operating personnel for an aggregate minimum of eight hours at the jobsite.

D. No additional payment shall be made for services required in Article 3.02.

3.03 ANALYTICAL SERVICES

A. The manufacturer shall be able to provide in-house lab analysis of the equipment media predicting the remaining life cycle of the media. Such service shall be provided at the manufacturer's expense.

B. No additional payment shall be made for services required in Article 3.03.

3.04 ACCEPTANCE

A. Demonstrate to the Engineer that the odor control system will function as required in these Specifications. The system supplier shall make, at his expense, necessary changes, modifications, and adjustments required to provide satisfactory operation.

B. Scrubber shall contain a full load of unspent media when accepted by the Owner.

C. No additional payment shall be made for services required in Article 3.04.

END OF SECTION 15885

SECTION 15890
AIR DISTRIBUTION DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work Included: Diffusers, Registers and Grilles

1.02 RELATED WORK

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.03 REFERENCES

A. Standards

1. National Fire Protection Association (NFPA): Standard 255, Test Methods for Surface Burning Characteristics of Building Materials.
2. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): ASHRAE Std 70, Method of Testing for Rating the Performance of Air Outlets and Inlets; 1991.
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
4. SMACNA HVAC Duct Construction Standards - Metal and Flexible; 1995, Second Edition with Addendum No. 1.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions.

B. Product Data: Data shall be submitted on the following items: Diffusers, Registers and Grilles.

1.05 QUALITY ASSURANCE

A. Manufacturers

1. Products scheduled on the drawings are the basis of design to establish performance criteria and size. Subject to compliance with these Specifications and the Drawings, the products of the following manufacturers are acceptable.
   a. Carnes
   b. Krueger
   c. Metal Aire
   d. Price
   e. Titus
   f. Tuttle & Bailey
   g. Or equal.

2. Manufacturer shall provide published performance data for all diffusers, registers and grilles. The devices shall be tested in accordance with ANSI/ASHRAE Standard 70.

1.06 DELIVERY, STORAGE AND HANDLING

A. Shipping

1. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
3. Deliver spare parts to the Owner after completion of work.

B. Receiving

1. Inspect and inventory items upon delivery to site.
2. Store and safeguard equipment, material and spare parts in accordance with manufacturers written instructions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Finish: Diffusers, registers and grilles shall be provided with a factory applied white baked enamel finish unless indicated otherwise, herein or on the Drawings. Diffuser, register and grille finishes must pass a 100-hour ASTM B117 corrosive environments salt spray test without creepage, blistering or deterioration of film; a 250-hour ASTM D870 water immersion test; and the ASTM D2794 reverse impact cracking test with a 50-inch pound force applied.

B. Mounting: Coordinate mounting with surface/assembly in which mounted and provide manufacturer's standard frame and border to application.

C. Performance: Air distribution device performance (pressure drop and NC) shall be as scheduled at design airflow.

D. Grilles, Registers, and Diffusers

1. Duct mounted Side wall Diffuser: Supply grilles shall be aluminum and the sizes of supply grilles shall be the same as shown on plans & schedules. The deflection blades shall be available to the long or short dimension of the grille. Construction shall be of aluminum with 1-1/4-inch wide border. Provide opposed blade volume damper.
2. Heavy Duty Return Grille, 0-degree Deflection: Heavy duty bar grille, 0° deflection; steel construction with a 1¼-inch wide, 16 gauge steel border for wall surface mounting; 14-gauge steel bars reinforced by perpendicular, steel supports spaced on 6-inch centers; fully welded corners with a reinforcing patch for extra strength; countersunk screw holes; heavy-gauge steel volume damper operable from the face of the grille.
3. Eggcrate Grille: Eggcrate return grille; 1"x1"x1" aluminum core grid with minimum 90% free area; 1¼-inch wide heavy gauge extruded aluminum border with countersink screw

holes; mitred corners mechanically interlocked together for rigid frame; baked anodic acrylic finish, white unless noted otherwise; .

PART 3 - EXECUTION

3.01 STORAGE

A. Air distribution devices shall be stored on wooden pallets or rails, covered by 6 mil polyethylene cover, taped in place, until ready for installation.

3.02 INSTALLATION

A. Air distribution devices installation shall be per manufacturer's instructions for specific application and these Construction Documents. Coordinate frame and border type with assembly in which installed.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Coordinate locations to avoid conflicts with partitions and ceiling features and devices (light fixtures, speakers, sprinklers, etc.) - coordinate with Architectural drawings.

C. Install diffusers to ductwork and wall surfaces with air tight connection. Provide continuous neoprene gasket around perimeter (concealed beneath device border frame).

D. Paint ductwork visible behind air outlets and inlets matte black.

E. Air distribution devices mounted in ductwork shall be secured to ductwork with sheet metal screws.

F. Air devices shall be installed flush and square to surface/assembly in which installed.

END OF SECTION 15890

SECTION 15891
DUCTWORK

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of rectangular, round and flat-oval ducts and plenums. The ducts shall be supplied for heating, ventilating and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gage. All systems shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the Fabricator's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any specific material. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the material being furnished. All costs associated with such changes and adjustments shall be included in the price bid for the Work shown and specified.

C. Related Work specified elsewhere:

1. Section 07900 – Caulking and Sealants.
2. Section 08110 - Steel Doors and Frames.
3. Section 15050 - Basic Mechanical Materials and Methods.
4. Section 15250 - Mechanical Insulation.
5. Section 15910 - Ductwork Accessories.
6. Section 15990 - Testing, Adjusting and Balancing of HVAC Systems.

D. Definitions

1. Sealing Requirements: For the purposes of duct system sealing requirements specified in this Section the following definitions apply:
   a. A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
   b. Joints include girth joints; branch and sub-branch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to duct; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data including details of construction relative to material, dimensions of individual components, profiles, and finishes for the following items:

a. Duct liner.
b. Sealing materials.
c. Fire-stopping materials.

2. Shop drawings from duct fabrication shop, drawn to scale not smaller than ¼ inch equals 1 foot, on drawing sheets same size as the Contract Drawings detailing:
   a. Fabrication, assembly and installation details for metal and glass fiber ducts, including plans, elevations, section, details of components and attachments to other Work.
   b. Duct layout, indicating pressure classifications and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled.
   c. Fittings.
   d. Reinforcing details and spacing.
   e. Seam and joint construction details.
   f. Penetrations through fire-rated and other partitions.
   g. Terminal unit, coil and humidifier installations.
   h. Hangers and supports, including methods for building attachment, vibration isolation and duct attachment.
3. Coordination drawings for ductwork installation shall show the following:
   a. Coordination with ceiling suspension members.
   b. Spatial coordination with other systems installed in the same space with the duct systems.
   c. Coordination of ceiling and wall mounted access doors and panels required to provide access to dampers and other operating devices.
   d. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.
4. Record drawings including duct systems routing, fittings, details, reinforcing, support and installed accessories and devices.
5. Maintenance data for volume control devices, fire dampers and smoke dampers.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASTM, American Society for Testing Materials.
2. ASME, American Society of Mechanical Engineers.
3. OSHA, Occupational Safety and Health Act.
4. ANSI, American National Standards Institute.
5. NFPA, National Fire Protection Association.
6. UL, Underwriters Laboratories, Inc.
7. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers.
8. SMACNA, Sheet Metal and Air Conditioning Contractors' National Association.
9. TIMA, Thermal Insulation Manufacturer's Association.
10. ICBO, International Conference of Building Officials.

1.04 QUALITY STANDARDS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

B. Manufacturer shall provide written certification that the equipment provided under this Specification has been designed in accordance with these Specifications and is suitable for these service conditions.

1.05 STORAGE AND HANDLING

A. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels identifying manufacturer, product name and designation, color, expiration period for use, pot life, curing time and mixing instructions for multi-component materials.

B. Store and handle sealant fire-stopping materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperature, contaminants or other causes.

C. Deliver and store stainless steel sheet with mill-applied adhesive protective paper, maintained through fabrication and installation.

1.06 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents for a period of 1 year after substantial completion.

PART 2 - PRODUCTS

2.01 METAL DUCT MATERIALS

A. Provide sheet metal in thicknesses indicated, packaged and marked as specified in ASTM A 700.

1. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

B. Reinforced shapes and plates, unless otherwise indicated, shall be galvanized steel reinforcing where installed on galvanized sheet metal ducts.

C. Tie-rods shall be galvanized steel, ¼-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer that 36 inches.

2.02 SEALING MATERIALS

A. Joint and Seam Sealants: The term sealant used in this Section is not limited to material of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

1. Joint and Seam Tape: 2-inch wide, Metallic Foil-faced not fabric type
2. Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant; formulated with a minimum of 75 percent solids.
3. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.
4. Fire-Resistant Sealant: Provide two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by UL or other testing and inspecting agency acceptable to authorities having jurisdiction.

2.03 WEATHERPROOF DUCT INSULATION

A. Provide a minimum of 74mm 3 inches of rigid cellular polyurethane thermal preformed board insulation, or rigid cellular phenolic thermal preformed board insulation on exterior of supply ducts, return ducts, and plenums exposed to the weather.

B. Coat sides, ends and edges of insulation with a waterproof mastic. Apply insulation in a solid bed waterproof adhesive and additionally secure with one 20 gauge galvanized metal stud welded to the metal ducts and having stainless steel washers not less than 51 mm or 2 inches in diameter under the metal mechanical fasteners for bearing on the insulation and to hold on in place.

C. Provide studs at a rate of one per .0929 Square meters 1 square foot metal duct, spaced at maximum of 305 mm 12" centers along both edges of top, bottom and sides of ducts and at joints in insulation.

D. After the insulation is in place, cover joints and corner joints, with glass fiber reinforcing mesh in waterproof adhesive.

E. After covering is complete, coat exterior surfaces of insulation with an approved waterproof and weather-resistant aluminum pigmented mastic recommended by the insulation manufacturer for this type of application. Apply mastic in 2 equal coats to a minimum thickness of 6.35 mm .25 inch; reinforce between coats with a layer of glass fiber reinforcing mesh; lap glass fiber reinforcing mesh 153 mm 6 inches at joints. Insulation less than 305 mm 12 inches in least dimension shall not be used along the edges of the duct bottom. Slope insulation from top center line of horizontal rectangular ducts to top edges ducts with a minimum slope 83mm 1 inch per foot.

2.04 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4-inch thick.

B. Hangers: Galvanized sheet steel or round, uncoated steel, threaded rod. Vibration isolators in areas of moisture shall be silicone or non-porous rubber material and not spring-type.

C. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

D. Straps and Rod Sizes: Conform with Table 4-1 SMACNA HVAC Duct Construction Standards for sheet steel width and gage and steel rod diameters. Hanger rods shall be a minimum of ¼" diameter.

E. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger.

F. Sleeves

1. Sleeves for round ductwork: Form with galvanized steel.
2. Sleeves for rectangular ductwork: Form with wood or galvanized steel.
3. Size sleeves large enough to allow for movement due to expansion and contraction.

G. For galvanized steel ducts provide hot-dipped galvanized steel support materials. .

2.05 RECTANGULAR DUCT FABRICATION

A. Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA HVAC Duct Construction Standards. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications and joint types and intervals.

B. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

C. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains and discoloration.

D. Static Pressure Classifications: Except where otherwise indicated, construct duct systems to the following pressure classifications:

1. Supply Ducts: 3 inches water gage.
2. Return Ducts: 2 inches water gage, negative pressure.

E. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gage or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA HVAC Duct Construction Standards, unless they are lined or are externally insulated.

2.06 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections and other duct construction in accordance with SMACNA HVAC Duct Construction Standard.

2.07 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve necessary thickness are prohibited.

B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

1. Butt transverse joints without gaps and coat joint with adhesive.
2. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

C. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

D. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

E. Secure transversely oriented liner edges facing the air stream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

1. Fan discharge.
2. Intervals of lined duct preceding unlined duct.

2.08 ODOR CONTROL SYSTEM

A. All materials, fabrication, and installation are specified under Section 15885 "Dry Media Odor Control System"

PART 3 - EXECUTION

3.01 INSTALLATION

A. Construct and install each duct system for the specific duct pressure classification indicated. Provide openings in ductwork where required to accommodate thermometers and controllers.

B. Install ducts with fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building line; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment.

1. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partition, except as specifically shown.
2. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.
3. Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Provide clearance of 1-inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

H. Install insulated ducts with 1-inch clearance outside of insulation.

I. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

3.02 SEAM AND JOINT SEALANT

A. Seal duct seams and joints to SMACNA Seal Class A (all transverse joints, longitudinal, seams, and duct penetrations). Seal externally insulated ducts prior to insulation installation.

3.03 HANGING AND SUPPORTING

A. Install rigid, round, rectangular and flat oval duct with support systems indicated in SMACNA HVAC Duct Construction Standards.

1. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.
2. Support vertical ducts at a maximum interval of 16 feet and at each floor.

B. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

C. Install concrete insert prior to placing concrete.

D. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.04 CONNECTIONS

A. Connect equipment with flexible connectors in accordance with Section 15910 Ductwork Accessories.

B. All duct connections shall comply with SMACNA HVAC Duct Construction Standards.

3.05 ADJUSTING AND CLEANING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required airflow. Adjustments shall be in accordance with Section 15990 Testing, Adjusting and Balancing Air Systems.

B. Vacuum ducts systems prior to final acceptance to remove dust and debris.

END OF SECTION 15891

SECTION 15895
FIBERGLASS DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Furnish, fabricate and install all fiberglass reinforced plastic (FRP) ductwork to include fittings, accessories, dampers, hangers and any incidental work or components required to provide complete air supply, return and exhaust ductwork systems as shown.

B. In general, ductwork shall consist of any passageway made of FRP substantially air-tight, used for the conveying of air, gas or materials. Included are fittings, transitions, bracing, fasteners, sealers, supports and accessories such as access panels, access doors, turning vanes and manual air balancing dampers. All ductwork shall be of size and material as specified herein and as shown on the Drawings. All duct sizes indicated on the Drawings are clear, inside dimensions.

C. Any change in duct sizes, offsets, transitions and fittings required to accommodate job conditions shall be manufactured in compliance with SMACNA construction standards and have a maximum transitional angle of 25 degrees.

1.02 SUBMITTALS

A. Submit to the Engineer in accordance with the General Conditions, the Special Conditions, and Division 1, the following drawings and data. Ductwork shop drawings shall include typical details of discharge nozzles, transitions, elbows, fittings, accessory items such as access panels or access doors, turning vanes, volume control and splitter dampers, volume extractors, hangers and supports, joining methods, bracing and material gages. Drawings of general layouts of individual systems shall be submitted, scale shall be 1/4-in. = 1-ft-.0-in. minimum.

B. The following additional data shall be submitted.

1. Manufacturer's qualification and experience data, specifications and installation instructions, factory and field quality control procedures catalog data, brochures, descriptive matter, illustrations, diagrams and color charts of ductwork to be selected.
2. Specific handling and storage requirements for ductwork, joint kits and resin systems.
3. Sample coupons of laminate not less than one foot square. Provide sample laminate coupons for each method of manufacture and for both round and rectangular duct manufacturing methods.
4. Resin system data, including chemical environment service test data, case history data of similar installations (with contact addresses), resin pot life and time versus temperature data required for complete resin cure for laminate thicknesses actually proposed.
5. Submit design calculations signed and sealed by a professional engineer for all delegated design tasks and fabrication procedures. Also submit a letter certifying that the laminates fabricated with the proposed resin system will give satisfactory performance under the specified service conditions and stating the service conditions for which certification is provided and indicating compliance with specified pressure and vacuum design criteria.

6. Submit construction details for flexible connectors, expansion joints, elbows, transitions, junctions, hangers and supports, and flanged fittings including dimensioned laminate cross sections and flange fabrication and assembly details.
7. Submit results of factory readings taken with "Barcol Hardness Impressor" and provide procedure to field check for complete cure of resin.
8. Certified service tables for the resins being used and the expected contaminants showing satisfactory services for the required design conditions.
9. Detailed instructions for field joining of the ductwork to include quality control procedures.
10. Submit shop test reports for fiberglass reinforced plastic dampers.

1.03 QUALITY ASSURANCE

A. All FRP duct, supports, and fittings shall be from a single manufacturer.

B. All materials shall be supplied by a Manufacturer experienced in the fabrication of materials similar to those specified. Design and engineering shall be performed by personnel regularly employed by the Manufacturer who are experienced in the design of FRP systems similar to those specified.

C. The Manufacturer shall provide factory trained personnel for training of installers and for supervision and inspection of the installation. The use of local sales representatives for this service is not acceptable.

D. Corrosion resistance data shall be based on ASTM C581.

1.04 DELIVERY, STORAGE AND HANDLING

A. Equipment, material and spare parts are to be shipped complete except where partial disassembly is required by transportation regulations or for protection of components. No ductwork or components shall be shipped prior to complete resin cure.

B. Inspection of the duct and components will be made by the engineer or other representative of the owner after delivery. Materials shall be subject to rejection at any time on account of failure to meet any of the specification requirements. Material rejected after delivery shall be marked for identification and shall be immediately removed from the jobsite.

1.05 STANDARDS OF CONSTRUCTION AND INSTALLATION

A. All ductwork construction and installation details shown on the Drawings and specified herein are based on acceptable methods of construction and installation and are intended to define the quality of construction and installation to be furnished. Alternate details may be submitted for approval.

1.06 REFERENCE STANDARDS

A. These standards shall be considered as minimum requirements. This is a general list and not all standards listed are necessarily referenced elsewhere in this Section. Specific requirements of this Section and/or Drawings shall have precedence. The Engineer shall resolve conflicts between published requirements.

B. Air Movement and Control Association (AMCA)

C. American National Standards Institute (ANSI)

1. ANSI RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment.

D. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

E. American Society for Testing and Materials (ASTM)

1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E477 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
3. ASTM C581 - Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service.
4. ASTM D4167

F. Anti-Friction Bearing Manufacturers Association (AFBMA)

G. National Fire Protection Association (NFPA)

1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems.
2. NFPA 91 - Standard for Exhaust Systems for Air Conveying of Materials.
3. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.
4. NFPA 255 - Standard Method for Test of Surface Burning Characteristics of Building Materials.

H. Occupational Safety and Health Administration (OSHA)

I. Underwriters Laboratories (UL)

1. UL 555 - UL Standard for Safety Fire Dampers.
2. UL 723 - UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.

J. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 - PRODUCTS

2.01 MATERIAL

A. Design Conditions

1. Temperature: minus 10 degrees F to 125 degrees F
2. Pressure: 12-in H2O w.g. positive; 12-in H2O w.g. negative
3. Flow medium and velocity: air at 3,500 feet per minute
4. Wind load: 120 mph

5. Wall thickness (minimum): Thickness as necessary to meet the requirements of Paragraph 2.03K.

B. The following materials are expected to be in the air stream or surrounding area. Vinylester resin shall be used for all ductwork.

1. Hydrogen sulfide
2. Ammonia
3. Sodium hydroxide
4. Sodium hypochlorite
5. Organic compounds

2.02 CLASSES OF CONSTRUCTION

A. Ductwork shall be designed and constructed in accordance with ASME/ANSI RTP1-1989.

2.03 FIBERGLASS REINFORCED PLASTIC (FRP) DUCTWORK

A. FRP ductwork shall be of contact molded or filament wound construction, or a combination of these methods, to meet design criteria.

B. FRP ductwork shall have a flame spread rating of 25 or less inside and outside and a smoke developed rating of not more than 50 in accordance with NFPA 91. Sprinklers shall not be used for internal fire suppression.

C. Laminates shall consist of a 20 mil (finished thickness) minimum chemical resistant interior liner with an apertured synthetic surface veil embedded in a resin rich surface. The corrosion barrier shall be a minimum of 100 mils thick and include not less than two layers of 1-1/2 ounce mat with 25 percent glass and 75 percent resin content. The structural layer shall be of sufficient thickness to meet the minimum thickness requirements specified. The exterior surface layer shall be resin rich "C" - glass or appertured nexus veil not less than 20 mils thick. Outside finish shall be a pigmented, parrafinated gel coat with an ultra violet inhibitor. The inner surface shall be free of cracks and crazing with a smooth finish and with an average of not over two pits per square foot, providing the pits are less than 1/8-in in diameter and not over 1/32-in deep and are covered with sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits.

D. Resins used in the laminate shall be premium corrosion resistant and fire retardant vinylester resins and shall contain 3 percent NYACOL as a fire retardant.

E. Fittings and Joints: All fittings such as elbows, laterals, tees and reducers shall be of the same resin as and equal or superior in strength to the adjacent duct section and shall have the same internal dimensions as the adjacent duct. Non-flanged duct joints shall be butt wrapped or bell and spigot joints. Bell and spigot joints shall be sealed with a standard butt joint overlay as per PS 15-69. The interior opening between the bell and spigot shall be sealed with a resin paste so that no glass fibers are exposed and all voids are filled. Field cut duct ends and exposed glass fibers shall be resin coated prior to joint assembly to maintain a continuous interior corrosion barrier. Coat all exterior surfaces of joints with a paraffinated resin-rich gel coat with UV inhibitors.

F. Total width of overlay for butt-wrap joints shall be not less than 6-in. for diameters from 6-in. up to and including 30-in., 36-in. and larger shall be not less than 10-in.

G. Round Standard Elbows

1. Standard elbow centerline radius shall be equal to 1.5 times the diameter.
2. Standard elbows up to 24-in. diameter shall be smooth radius molded elbows. Standard elbows 30-in. diameter and greater may be mitered sections as specified below.
3. 0 to 44 degree elbows shall contain one mitered joint and two sections. 45 to 80 degree elbows shall have a minimum of two mitered joints and three sections. Elbows greater than 80 degrees shall have a minimum of four mitered joints and five sections.

H. Rectangular Fittings

1. Fittings shall be factory manufactured to meet the specified design criteria and in accordance with approved submittals. Factory install reinforcing ribs as required to meet the specified deflection requirements and to provide a system free from pulsing, warpage, sagging and undue vibration.
2. forming vanes in all mitered rectangular elbows. Rectangular elbow turning vanes shall be of FRP construction, solid or double wall construction with an airfoil shaped profile.

I. Reinforcing

1. Round duct reinforcing shall be factory installed with spacing between reinforcing located to avoid all hangers and support saddles.
2. Rectangular duct and fitting reinforcing shall be factory located and installed to avoid duct hangers, support saddles, bracing, branch take offs and entries, and plenum connections. Routine field cutting and field relocation of factory installed reinforcing is not acceptable.

J. Tolerances

1. Out-of-roundness of duct shall be limited to plus or minus 1/8-in. or plus or minus one percent of duct inside diameter, whichever is greater for duct sizes 6-in. diameter and greater.
2. Rectangular duct tolerances shall be 3/16-in. for duct diameter up to 18-in. and plus or minus one percent for dimensions of over 18-in.
3. All unflanged duct shall be square on the ends in relation to the pipe axis and plus or minus 1/8-in. up to and including 24-in. diameter and plus or minus 3/16-in. for all diameters greater than 24-in.
4. Fittings
   a. The tolerance on angles of all fittings shall be plus or minus one degree, up to and including 24-in. diameter and plus or minus ½ degree for 30-in. diameter and above.
5. Flanges
   a. Flange faces shall be perpendicular to the axis of the duct within ½ degree.
   b. Flange faces shall be flat to within plus or minus 1/32-in., up to and including 18-in. diameter and flat within plus or minus 1/16-in. for 20-in. diameter and larger.
   c. Provide custom filler pieces as required to mate flanges squarely.

K. Calculations for wall thickness determination shall be based on the structural fiberglass reinforced wall only. Long term deflection shall not exceed one percent of duct diameter or duct width for rectangular ducts. Round and rectangular FRP ductwork shall be designed using a safety factor of 10 to 1 for pressure, a safety factor of 5 to 1 for vacuum service, and a wind load of 120 mph. Round duct shall be designed by Manufacturer to resist specified loadings but in no case shall FRP duct be less than the following thicknesses (without 0.10-in. liner and without exterior gel-coat thickness):

Diameter (-in)*	Filament Wound Thickness (-in)	Hand Layup Thickness (-in)
Less than 24	.225	.250
36 -42**	.375	.438

* Where rectangular duct is used the longest dimension shall be considered equivalent to diameter.

** Rectangular duct may be reinforced with angles or tees as required to meet the required pressure/vacuum service.

L. Ductwork with any portion of wall less than the required thickness shall be rejected.

M. All connections to expansion joints, butterfly dampers, fire dampers, tanks, or other equipment shall be flanged. Gaskets shall be chlorobutyl. Flanges shall be hand laid up to thickness specified in PS 15-69 except that minimum thickness shall be 3/4-in. Each flange face shall be ground flat, and a new 100 mil corrosion barrier shall be applied. The flange shall be anchored to a waxed table to ensure the flatness tolerance outlined above. The face shall be textured for use with full face chlorobutyl gaskets, 1/8-in. minimum thickness. Flange drilling shall be as per PS 15-69. All bolt holes shall be back spot faced for a washer seat. All flange bolts shall be torqued to values as recommended by manufacturer.

N. Fasteners: Furnish all bolts, nuts, washers and other fasteners required. Material of metallic fasteners shall be Series 316 stainless steel.

O. There shall be not less than a 1/4-in. buildup of FRP over the duct at each support and as shown on the Drawings.

P. Provide 1-in. minimum PVC pipe and PVC ball valve duct drains in the bottom of all main, branch and riser ducts to allow removal of condensate.

Q. All hangers and supports shall be Type 304 stainless steel. All duct hangers shall be provided per SMACNA recommendations and manufacturers requirements. Maximum spacing on duct hanger is 5'-0".

2.04 FLEXIBLE CONNECTORS

A. Furnish flexible connectors at each inlet and outlet of fan and in the duct runs where required for expansion, contraction and movement. Flexible connections shall be W-design units constructed of EPDM rubber 3/8-in. thick, reinforced with a strong synthetic asbestos-free fabric suitable for corrosive service. The flexible connections shall be designed to minimize the transmission of vibration from the fans to the ductwork at the suction and discharge connections. Expansion or contraction flexible connections shall be designed to allow 1-in. movement. Working length or "live" length shall be as designed by the Manufacturer to allow up to 1-in. of movement. Ends shall be flanged, with flanges matching duct connection flanges. Corners on rectangular expansion joints shall be molded and free of patches or splices. The flexible connections shall be

suitable for outdoor service and temperature ranges from minus 10 degrees F up to 125 degrees F, and pressure to 5 psig. Specially fabricated split Type 316 stainless steel retaining back-up bars shall be supplied to prevent damage to the EPDM rubber flanges when Type 316 stainless steel bolts are tightened.

1. Manufacturer:
   a. Holz Rubber Company.
   b. Mercer Rubber Company.
   c. Proco Products, Incorporated.
   d. Or equal.

2.05 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. The duct system shall be furnished with the following:

1. One set of special tools required to maintain and repair the system.
2. All materials in kit form to make or repair joints. Additional kits shall be supplied sufficient to repair 10 percent of the joints. Materials shall be packaged in a painted steel case for long term storage.
3. Names and addresses of all manufacturers of: Fiberglass reinforcements, resins, hardeners and components used to repair and maintain the FRP duct system.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location, and provided in accordance with Section 01600.

C. Prices for spare parts and tools shall remain in effect for one year after final acceptance.

D. Material Safety data sheets for all components must be furnished.

2.06 FRP TRANSITION PIECES

A. Provide transition pieces as shown on Drawings and herein specified.

B. Construction:

1. Thickness of transition pieces shall be designed using a safety factor of 10 to 1 for pressure, a safety factor of 5 to 1 for vacuum service, and wind load of 120 mph, all with the pressure classification listed below.
2. Custom flanges shall be designed as required to connect to fans, coils, dampers and duct work. Coordinate flange sizes to match approved equipment dimensions.

C. Pressure Classification: Manufacturer shall design transition pieces so that they shall be free from buckling, pulsing, warpage and sagging at design pressures.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All ductwork shall be fabricated and erected where shown on the Drawings or as specified herein. Ductwork shall be rigidly supported and secured in an approved manner. Bracing and vibration isolators shall be installed, where necessary, to eliminate vibration, rattle and noise. Hangers shall be installed plumb and securely suspended from supplementary steel or inserts in concrete slabs. Lower ends of hanger rods shall be sufficiently threaded to allow for adequate vertical adjustment. Building siding and metal decking shall not be used to hang ductwork.

B. Wherever ducts are divided, the cross-sectional area shall be maintained. All such changes must be approved and installed as directed by the Engineer or as approved on shop or erection drawings.

C. During installation the open ends of ducts shall be closed to prevent debris and dirt from entering. Work shall be installed in accordance with the overall approved progress schedule and in cooperation with all other trades so there will be no delay to other trades.

D. The Drawings of the air ducts and air risers indicate the general location for installation of the ducts and risers. Should additional offsets or changes in direction be made, these changes must be considered in the original bid and shall be installed at no additional cost to the Owner.

E. All necessary allowances and provisions shall be made in the installation of the ducts for the structural conditions of the building. Ducts shall be transformed or divided as may be required. Wherever this is necessary, the cross-sectional area shall be maintained. All of these changes, however, must be approved and ducts installed as directed by the Engineer or as approved on shop or erection drawings.

F. The taper of all transformations shall be not more than 15 degrees.

G. Do not remove or alter factory installed duct reinforcing ribs except as required to accommodate duct alterations due to unexpected field conditions. Notify the Owners representative prior to starting any field modifications involving ductwork structural reinforcing members. Submit additional design calculations to demonstrate structural design integrity of ductwork and fittings requiring reinforcing modifications in the field.

H. No ductwork or components shall be shipped prior to complete resin cure.

3.02 DUCTWORK FITTINGS AND ACCESSORY ITEMS

A. Duct Elbows - Changes in direction and offsets shall be made in a gradual manner to facilitate streamline flow of air. All elbows shall have a centerline radius of not less than 1-1/2 times the width of the duct in the plane of the elbow. For rectangular ductwork where full radius elbows cannot be installed or abrupt elbows are shown, provide abrupt elbows equipped with shop-installed hollow, fiberglass air foil turning vanes. An access door shall be installed at each abrupt elbow, so located for easy access to turning vanes.

3.03 SUPPORTING OUTDOOR DUCTS

A. Performance Requirements

1. Delegated Design: Design FRP Duct supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2. Structural Performance: Hangers and supports for FRP Duct shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   a. See structural plans and specifications for wind load criteria.
   b. See structural plans and specifications for seismic load criteria.

3.04 QUALITY

A. All ductwork shall be free from pulsation, chatter, vibration or objectionable noise. After system is in operation, should these defects appear they shall be corrected by removing, replacing or reinforcing the work. Sound levels shall not exceed the minimum requirement as specified in ASHRAE 1980 Systems Volume, page 35.16, Table 23. No discreet tones will be allowed.

B. The maximum allowable leakage shall be 5 percent of air volume.

C. The Engineer reserves the right to reject acceptance of delivery of any or all pieces of equipment found upon inspection to have any or all of the following defects in the laminate:

1. Blisters
2. Chips
3. Crazing
4. Exposed glass
5. Cracks
6. Burned areas
7. Dry spots
8. Foreign matter
9. Surface porosity
10. Sharp discontinuity
11. Trapped air
12. Any item which does not satisfy the tolerances as specified.

3.05 CLEANING OF DUCTWORK

A. All ductwork, fans, outlets and other parts of the ductwork systems shall be maintained in a clean condition during installation.

B. Complete ductwork systems shall be cleaned prior to testing and air balancing. Cheese cloth shall be secured over all openings of the ductwork system for entrapment of dirt during the cleaning operation.

3.06 PAINTING

A. Louver blank-off panels and ductwork visible through louvers in exterior walls are to be painted black. Painting shall be performed under this Section and shall be as specified in Division 9.

3.07 TEST PORTS

A. Where shown on the Drawings and where required for testing and balancing instrument insertion ports shall be provided. Size and location of ports shall be coordinated with the Contractor performing air balancing. Ports shall be sealed with plastic snap lock plugs.

END OF SECTION 15895

SECTION 15899
PACKAGED OUTDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes packaged, outdoor, central-station air-handling units with the following components and accessories:

1. Direct-expansion cooling..
2. Economizer outdoor- and return-air damper section.
3. Integral, space temperature controls.

1.02 DEFINITIONS

A. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

B. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

E. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Conform to the requirements indicated on the structural (Drawing S001) and other Contract Documents, where applicable.

B. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.04 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and maintenance data.

E. Warranty.

1.05 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigerant system safety.
2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
3. Comply with applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.06 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.

4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Carrier Corporation.
2. McQuay International.
3. Trane; American Standard Companies, Inc.
4. YORK International Corporation.
5. AAON

2.02 CASING

A. Casing shall be insulated single wall construction.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.

1. Exterior Casing Thickness: 0.0626 inch (1.6 mm) thick.

C. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch (25 mm).
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

D. Condensate Drain Pans: Formed sections of stainless -steel sheet, a minimum of 2 inches (50 mm) deep, and complying with ASHRAE 62.1-2004.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple both sides of drain pan.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

E. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

2.03 FANS

A. Direct-Driven Supply-Air Fans: Double width, forward curved centrifugal; with permanently lubricated, motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Fan Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.04 COILS

A. Supply-Air Refrigerant Coil:

1. Copper-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1-2001.
5. Provide factory applied phenolic coating that will be compatible with the operating environment.

B. Outdoor-Air Refrigerant Coil:

1. Copper-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Provide factory applied phenolic coating that will be compatible with the operating environment.

2.05 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two

B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-407C or R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.

2.06 AIR FILTRATION

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.

1. Glass Fiber: Minimum 80 percent arrestance, and MERV 13.
2. Pleated: Minimum 80 percent arrestance, and MERV 13.

2.07 DAMPERS

A. Outdoor-Air Damper: Linked damper blades, for 0 to 100 percent outdoor air, with motorized damper.

B. Outdoor and Return-Air Mixing Dampers: opposed-blade, galvanized-steel dampers mechanically fastened to cadmium plated steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1-2004, with bird screen and hood.

2.08 ELECTRICAL POWER CONNECTION

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.09 CONTROLS

A. Control sequence of operation shall be as specified in Section 15950 HVAC Controls.

B. Basic Unit Controls:

1. Control-voltage transformer.

2. Wall-mounted thermostat or sensor with the following features:
   a. Heat-cool-off switch.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.
   i. Unoccupied-period-override push button.
   j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
3. Remote Wall Mounted Annunciator Panel for Each Unit:
   a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
   b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
   c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

C. DDC Controller:

1. Controller shall have volatile-memory backup.
2. Safety Control Operation:
   a. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 16 Section Addressable Fire Alarm System – Systems Operational Description
3. Scheduled Operation: Occupied and unoccupied periods on seven 365-day clock with a minimum of two programmable periods per day.
4. Unoccupied Period:
   a. Heating Setback: 10 deg F. (5.6 deg C)
   b. Cooling Setback: 10 deg. F.
   c. Override Operation: Two hours.
5. Supply Fan Operation:
   a. Occupied Periods: Cycle fan to maintain space temperature.
   b. Unoccupied Periods: Cycle fan to maintain setback temperature.
6. Refrigerant Circuit Operation:
   a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure.
   b. Unoccupied Periods: Compressors off.

7. Gas Furnace Operation:
   a. Occupied Periods: Modulate burner to maintain room temperature.
   b. Unoccupied Periods: Cycle burner to maintain setback temperature.

D. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
3. Provide BACnet or LonWorks compatible interface for central HVAC control workstation for the following:
   a. Adjusting set points.
   b. Monitoring supply fan start, stop, and operation.
   c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
   d. Monitoring occupied and unoccupied operations.

2.10 ACCESSORIES

A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

C. Coil guards of painted, galvanized-steel wire.

D. Hail guards of galvanized steel, painted to match casing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." ARI Guideline B. Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 Section "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

B. Install wind and seismic restraints according to manufacturer's written instructions. Wind and seismically restrained vibration isolation roof-curb rails are specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Install condensate drain, minimum connection size, with trap and indirect connection to nearest sanitary drain or area drain.

D. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
2. Install normal-weight, 3000-psi (20.7-MPa), compressive strength (28-day) concrete mix inside roof curb, 4 inches (100 mm)thick. Concrete, formwork, and reinforcement are specified in Division 03.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

B. Tests and Inspections:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Remove and replace malfunctioning units and retest as specified above.

3.03 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 15899

SECTION 15910
DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work specified in this Section is subject to the provisions of Section 15050.

B. Furnish and install ductwork accessories as necessary to install ductwork shown on the Contract Documents.

1.02 REFERENCES

A. This Specification references the latest edition of the publications listed below. Work shall be performed and materials shall be furnished in accordance with these publications where referenced herein:

1. Standard Mechanical Code.
2. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) Standards:
   a. HVAC Duct Construction Standards.
   b. Thermoplastic Duct (PV) Construction Manual.
   c. HVAC Systems Duct Design.
   d. Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems.
   e. Rectangular Industrial Duct Construction Standards.
   f. Round Industrial Duct Construction Standards.
3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standards:
   a. Equipment.
   b. HVAC Systems and Applications.
   c. Refrigeration.
   d. Fundamentals.
4. National Fire Protection Association (NFPA) Standards:
   a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
   b. NFPA 90B - Warm Air Heating and Air Conditioning Systems.
5. Underwriter's Laboratories (UL) Standards:
   a. Factory Made Air Ducts and Connectors.
   b. UL 555 - Fire and Radiation Dampers.
   c. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions.

B. Submit product data on all ductwork accessories proposed for installation under this Section, including, but not limited to the following:

1. Air turning vanes.
2. Volume control dampers.
3. Backdraft dampers.
4. Spin-in collar fittings.
5. Flexible duct connectors.
6. Duct access doors.

C. Submittal data shall include catalog cuts, performance data, installation instructions and other information required to completely describe the proposed equipment and allow verification of conformance with the Specifications.

PART 2 - PRODUCTS

2.01 AIR TURNING DEVICES

A. Turning vanes shall be installed in all 90 degree square and rectangular elbows and at other locations shown. The turning vanes shall be double thickness type, with vanes secured to the runners and runners secured to the duct. Elbows in round ductwork and other radiused elbows shall have an inside radius equal to the diameter of the duct.

B. Splitters shall be made of the same thickness galvanized steel as the duct, 24 gauge minimum securely attached to a rod at the air leading edge and made of two thicknesses so the leading edge presents a round nose to air flow. Length shall be equal to 1-1/2 times the width of the smaller duct; 12-inch minimum.

2.02 VOLUME CONTROL DAMPERS

A. Single blade (up to 8-inches high), multi-blade (over 10-inches high), control damper.

B. Blades: Minimum 16 gauge galvanized steel, or extruded aluminum airfoil shape:

1. Pivot Rods: Steel, minimum ½-inch diameter or hex, 6-inches long. One rod extended to permit operation of damper from outside duct.
2. Maximum length 42-inches; maximum width 8-inches.
3. At Points of Contact, Except for Manual Balancing Application: Interlocking or overlapping edges, and compressible neoprene or extruded vinyl blade seals, designed for temperature of minimum 40 degrees F at specified leakage rate. In addition, hot and cold deck dampers, and dampers opening to the outside shall have compressible metal side seals.
4. Except for Manual Balancing Application, Leakage When Closed: Guaranteed less than 10 cfm per square foot at both 1-inch and 4-inches WG static pressure.
5. Opposed blade type for balancing and modulating applications, parallel blade type for 2-position applications.

C. Frames: Galvanized steel bar minimum 2-inches wide x 12 gauge for dampers 10-inches high or less, 3-1/2 x 7/8-inches, 16 gauge galvanized roll-formed channel with double thickness edges or 5 x 1 x 0.125-inch extruded aluminum channel for 11-inches high and larger.

1. Corner bracing.
2. Full size of duct or opening in which installed.

D. Bearings: Bronze sleeve, steel ball type, or Cycoloy 800.

1. Vertically Mounted: Thrust bearings.
2. Maximum Spacing: 42-inches.

E. Manually operated dampers shall be provided with cadmium-plated steel quadrant with device for locking damper in position.

2.03 BACKDRAFT DAMPERS

A. Heavy-duty damper with anti-leakage features, counter-balanced, parallel blade operation.

B. Operating Linkage: Factory assembled, steel construction.

C. Counterbalance Weight: Adjustable and mounted on the entering side. Not required on dampers located in ductwork on the discharge of fans.

D. Frame: 16 gauge galvanized 3-1/2-inch channel with 7/8-inch double thickness flanges and corner bracing. Top and bottom stops and blade end seals shall be provided with galvanized angles spot welded to frame and sealed with sealer. Face of angles shall have replaceable, compressible polyurethane or neoprene seals.

E. Blades: Minimum 14 gauge extruded aluminum with extruded vinyl seals locked into blade edges; maximum length 48-inches. Pivot rods shall be plated steel or molded synthetic thermoplastic, ½-inch diameter or hex.

2.04 FIRE DAMPERS

A. Fire dampers shall be installed at all locations where ductwork penetrates any floor wall or partition with a fire rating of two hours or more or where otherwise shown on the Drawings. Fire dampers shall have a rating compatible with the floor, wall, or partition and shall be classified and labeled in accordance with UL 555.

B. Fire dampers shall be of formed light gauge steel or metal box frame construction with the damper located out of the air stream when fully open.

C. Acceptable Manufacturers: Air Balance, Nailor-Hart, Prefco, Ruskin or Greenheck.

2.05 SPIN-IN-COLLAR FITTINGS

A. Complete with air scoop and manual damper with locking device, for round duct connection to supply duct. Spin-in collars shall be by the same manufacturer as the flexible duct and shall be provided for each flexible duct take-off.

2.06 FLEXIBLE DUCT CONNECTIONS

A. Flexible duct connections shall be non-combustible, installed at all belt-driven equipment and where shown. Material shall be glass fabric double coated with neoprene (30 ounces per square yard minimum).

B. Provide duct supports on each side of flexible connections.

C. Connections to kitchen exhaust fans shall be designed for continuous use at 300 degrees F without using asbestos and shall be designed for use with grease laden air.

D. Acceptable Manufacturers: Ventfabrics, Duro-Dyne (Adamson Company), Thermaflex or Frenzelit.

2.07 DUCT ACCESS DOORS

A. Furnish in ductwork as indicated and wherever necessary for proper access to all instruments, controls, fire dampers, motorized dampers and equipment and for convenient inspection, maintenance and replacement of same, size to be ample for usage. Openings shall be reinforced on all sides with material or ductwork in which doors are installed. Access doors shall have a minimum length of 8"

B. Two-piece pan construction, consisting of outer side crimped over inner dished side. Not less than two hinges and not less than two heavy cam latches. All contact surfaces of doors covered with heavy dense felt securely fastened in place to make doors air-tight.

C. Access doors to be insulated or soundproofed with same material as ducts or casings where located.

D. Coordinate the location of access doors above inaccessible ceilings with the Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All ductwork accessories shall be installed in strict accordance with manufacturer's recommendations.

B. Verify operation of dampers without binding of the linkage throughout entire operating range.

C. Install flexible duct connectors with fabric in the midpoint of flexible range when in the static condition. Verify that full extension or compression is not reached in the operating mode.

D. Verify duct access door installation allows adequate accessibility to the duct device intended for access.

END OF SECTION 15910

SECTION 15950
HVAC CONTROLS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for complete and operable HVAC controls. Extent of electric control systems work required by this Section is indicated on Drawings and Schedules, and by requirements of this Section. Control sequences are specified in this Section.

B. Refer to other Division 15 Sections for installation of manual volume dampers in mechanical systems.

C. All work shall be in compliance with current editions of THE National Electrical Code and ASHRAE design standards.

D. Refer to Division 16 Sections for the following work:

E. Power supply wiring for power source to control panels, starters, disconnects, and required electrical devices, except where specified as furnished, or factory-installed, by manufacturer.

F. Furnish control and interlock wiring under this section between field installed controls, indicating devices, motorized damper operators and unit control panels in compliance with the requirements of Division 16.

G. Control panel enclosures, starters, and disconnect switches shall be furnished under this section in accordance with the requirements specified under Section 11400.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product Data. Manufacturer's technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, and including installation instructions and start-up instructions.
2. Schematic flow diagram of system showing fans, dampers, and control devices.
3. Label each control device with setting or adjustable range of control.
4. Control interlock wiring diagrams. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
5. Details of faces of control panels, including controls, instruments, and labeling.
6. Written description of sequence of operation.
7. Wiring diagrams.
8. Operation and maintenance manuals.

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Only firms regularly engaged in the manufacture of electric control equipment of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years shall be eligible to provide and install the equipment specified herein.

B. Codes and Standards

1. Electrical Standards. Provide electrical products, which have been tested, listed and labeled by UL and comply with NEMA standards.
2. NEMA Compliance. Comply with NEMA standards pertaining to components and devices for electric control systems.
3. NFPA Compliance. Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.04 QUALITY STANDARDS

A. Manufacturer. Subject to compliance with requirements, provide electric control systems of one of the following.

1. Barber-Colman Co.
2. Honeywell, Inc.
3. Johnson Controls, Inc.
4. Landis & Gyr Powers, Inc.
5. Robertshaw Controls Co.
6. Or equal.

1.05 DELIVERY, STORAGE AND HANDLING

A. Provide factory shipping cartons for each piece of equipment, and control device. Maintain cartons through shipping, storage and handling as required to prevent equipment damage, and to protect equipment from dirt and moisture. Store equipment and materials inside and in original shipping packaging.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General. Provide electric control products in sizes and capacities indicated, consisting of dampers, thermostats, sensors, controllers, and other components as required for a complete installation. Except as otherwise indicated, provide manufacturer's standard control system components as indicated by published product information, designed and constructed as recommended by manufacturer. Provide electric control systems with the following functional and construction features as indicated.

B. Dampers. Provide automatic control low leakage dampers as indicated, with damper frames not less than formed 13-ga galvanized steel. Provide mounting holes for duct or louver mounting as required. Provide damper blades not less than formed 16-ga galvanized steel, with maximum blade width of 8". Equip dampers with motors, with proper rating for each application. Damper section widths shall not exceed 48 inches.

1. Secure blades to ½" diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings of nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc plated steel and brass. Submit leakage and flow characteristics, plus size schedule for controlled dampers.
2. For standard applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with optional closed-cell neoprene edging.
3. For outside air dampers applications as indicated, provide parallel or opposed blade design (as selected by manufacturer's sizing techniques) with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm/sq. ft. of damper area, at differential pressure of 4" w.g. when damper is being held by torque of 50 inch-pounds.

C. Damper Motors. Size each electric damper motor to operate dampers or valves with sufficient reserve power to provide 2-position action as specified. Damper motors shall be suitable for 120-volt, single phase power and each motor shall be arranged to fail to its last position.

D. Room Thermostats. Provide room thermostats with locking covers, and with concealed or readily-accessible adjustment devices and dead band, as indicated.

1. Provide thermostats with spiral bimetallic thermometers.
2. Thermostats. Provide 24 VAC thermostats of the bimetal actuated open contact, or bellows actuated enclosed snap-switch type, or equivalent solid-state type. Thermostat shall be UL-listed at electrical rating comparable with application. Provide bimetal thermostats, which employ heat anticipation.
3. Thermostat for split system air-conditioning unit shall be by the unit manufacturer.

E. Electric Contactors. Provide contactors for operating or limit control of electric heating loads, which are UL-listed for 100,000 cycles of resistive loads. Equip with replaceable molded coils and replaceable silver cadmium oxide contacts. Coat core laminations with heat-resistant inorganic film to reduce core losses. Provide line and load terminals on contactors with higher-than-35-amp rating, or provide one-piece formed-and-welded pressure type. Provide screw-type contactors for 35-amp-or-lower rating. Equip field-mounted contactors with suitable steel enclosures; and provide open-type mounting for those installed in factory-fabricated panels.

F. Fan Switches: Provide fan switches where indicated on the Drawings. Switches shall be factory sealed, shall be rated 600 VAC heavy-duty and shall have indicating lights. Selector switches shall be two or three position as indicated on the Drawings:

1. START/STOP.
2. HAND/OFF/AUTO.

G. Control Wiring: All control, interlock and starting circuit wiring, except where otherwise specified or noted on the plans, are to be furnished under this Section. Line voltage wiring shall

not be smaller than #14, 600 volt wire. All wire shall be run in conduit with outlet boxes and fittings in compliance with the requirements of Division 16, Electrical.

1. 24 volt wiring shall be not less than #18 gauge, with 600 volt insulation. Wiring run in partitions or above ceilings shall be run in plenum rated cable.
2. Control voltage shall not exceed 120 volts. Provide transformers and relays to comply with this requirement.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine areas and conditions under which electric control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF ELECTRIC CONTROL SYSTEMS

A. General. Install systems and materials in accordance with manufacturer's instructions and roughing-in drawings, and details on drawings. Install electrical components and use electrical products complying with requirements of applicable Division 16 Sections of these Specifications. Mount controllers at convenient locations and heights.

B. Control Wiring. The term "control wiring" is defined to include provision of wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices.

C. Wiring System. Install complete control wiring system for electric control systems. Conceal wiring, except in mechanical rooms and areas where other conduit and piping are exposed. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

D. Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system.

3.03 ADJUSTING AND CLEANING

A. Start-Up. Start-up, test, and adjust electric control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Cleaning. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Final Adjustment. After completion of installation, adjust thermostats, damper operators, motors and similar equipment provided as work of this Section. Final adjustment shall be performed by specially trained personnel in direct employ of the manufacturer of primary temperature control system.

3.04 CLOSEOUT PROCEDURES

A. City's Instructions. Provide services of manufacturer's technical representative for four hours to instruct City's personnel in operation and maintenance of electric control systems. Schedule instruction with Engineer, provide at least 7-days of notice to Contractor and Engineer for training date.

3.05 SEQUENCE OF OPERATION

A. Odor Control -Units OC-401 & OC-501

1. Refer to specification section 13150-10 for sequence of operation for odor control unit OC-401.
2. Refer to specification section 13150-11 for sequence of operation for odor control unit OC-501.

B. Diversion Building

1. Air Handling Units
   a. AH-301 & AH-302 will modulate according to a thermostat located in the space, AH-302 is a 100% redundant unit for AH-301 and at a loss of power to AH-301, a maintenance worker will energize AH-302 at which point the respective motor operated dampers located in the main ductwork will cycle to allow for air from the air handling unit to flow to the space. The unit supplier shall provide an enthalpy controller so when the outdoor air temperature is 55 or lower and the humidity level is 50% or lower the unit will enter the economizer cycle and when the outdoor conditions rise above these set points then the economizer cycle will cease and the compressor will be engaged.
2. Ventilation Exhaust Fans
   a. There are two (2) ventilation exhaust fans. The fans shall operate on a lead control basis. The lead fan shall be energized by a signal from the Process Control System. Once energized the fan shall run continuously until a signal from the Process Control System to de-energize. The second fan is a 100% Standby backup. Once air flow is verified by an air flow switch, a signal shall be transmitted to the Process Controls that the process pumps may be started On a loss of air flow from the Lead fan, verified by the air flow switch, the backup fan shall be energized. If the secondary fan air flow is not established, then a signal shall be transmitted to the process control system to shut down the process pump(s) and send and alarm annunciation to the Process Control Room.
3. Unit Heater
   a. The Process Control System shall transmit a signal to enable power to the Unit Heaters. The unit heaters shall be started and stopped by a unit mounted thermostat. The unit heaters shall shutdown by the unit mounted thermostat and/or a signal from the Process Control System

C. Jet Mix Building

1. Air Handling Units
   a. AH-701 & AH-702 will modulate according to a thermostat located in the space AH-702 is a 100% redundant unit for AH-701 and at a loss of power to ahu-701 a maintenance worker will energize AH-702 at which point the respective motor operated dampers

located in the main ductwork will cycle to allow for air from the air handling unit to flow to the space. The unit supplier shall provide an enthalpy controller so when the outdoor air temperature is 55 or lower and the humidity level is 50% or lower the unit will enter the economizer cycle and when the outdoor conditions rise above these set points then the economizer cycle will cease and the compressor will be engaged.

2. Exhaust Fans
   a. Toilet Exhaust : The toilet exhaust shall be controlled on-off by a room wall switch.
   b. Ventilation Fans : There are two (2) ventilation exhaust fans. The fans shall operate on a lead control basis. The lead fan shall be energized by a signal from the Process Control System. Once energized the fan shall run continuously until a signal from the Process Control System to de- energize. The second fan is a 100% Standby backup. Once air flow is verified by an air flow switch, a signal shall be transmitted to the Process Controls that the process pumps may be started on a loss of air flow from the Lead fan, verified by the air flow switch, the backup fan shall be energized. If the secondary fan air flow is not established, then a signal shall be transmitted to the process control system to shut down the process pump(s) and send an alarm annunciation to the Process Control Room.

3. Unit Heaters
   a. The Process Control System shall transmit a signal to enable power to the Unit Heaters.
   b. The unit heaters shall be started and stopped by a unit mounted thermostat. The unit heaters shall shutdown by the unit mounted thermostat and/or a signal from the Process Control System.

END OF SECTION 15950

SECTION 15990
TESTING, ADJUSTING AND BALANCING OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Work described in this Section specifies the requirements and procedures for HVAC systems testing, adjusting and balancing. Requirements include measurement and establishment of the fluid quantities of the HVAC systems as required to meet design specifications, and recording and reporting the results.

B. The Contractor shall procure the services of an independent air balance and testing agency, who is a current member in good standing of the Associated Air Balance Council (AABC), approved by the Engineer and who specializes in the testing, balancing and adjusting of heating, ventilating and air conditioning systems. The agency shall be certified by the National Environmental Balancing Bureau (NEBB) in those testing and balancing disciplines required for this Project and having at least one Professional Engineer registered in the state in which the services are to be performed and certified by NEBB as a Test and Balance Engineer.

C. Test and balance all HVAC systems including the following:

1. Supply air systems, all pressure ranges including variable volume and double duct systems.
2. Return air systems.
3. Verify temperature control system operation.

D. Test systems for proper sound and vibration levels.

1. Related Work specified elsewhere: Section 15950 - HVAC Controls.

E. Definitions

1. Systems testing, adjusting and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes:
   a. The balance of air distribution.
   b. Adjustment of total system to provide design quantities.
   c. Electrical measurement.
   d. Verification of performance of all equipment and automatic controls.
   e. Sound and vibration measurement.
2. Test: To determine quantitative performance of equipment.
3. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment.
4. Balance: To proportion flows within the distribution system (submains, branches and terminals) according to specified design quantities.
5. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

6. Report forms: Test data sheets arranged for collecting data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.

7. Terminal: The point where the controlled fluid enters or leaves the distribution system. There are supply outlets on air terminals and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers and hoods.

1.02 REFERENCES

A. This Specification references the latest edition of the publications listed below. Work shall be performed and materials shall be furnished in accordance with these publications as reference herein:

1. Associated Air Balance Council (AABC) Standards: National Standards for Total System Balance.

2. National Environmental Balancing Bureau (NEBB) Standards: Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

3. Sheet Metal and Air Conditioning Contractor's National Association (SMACNA) Standards: HVAC Systems Testing, Adjusting and Balancing.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the General Condition of the Contract Documents. In addition, the following specific information shall be provided:

1. Submit testing agency's name for approval; include resume of at least ten similar projects including testing dates, project name, system description and contractor.

2. Name of certified Test and Balance Engineer assigned to supervise the procedure and the technicians proposed to perform the procedures.

3. Submit a synopsis of the testing, adjusting and balancing procedures and agenda proposed for the Project.

4. Maintenance and operating data that includes how to test, adjust and balance the building systems.

5. Copies of test reports intended for use.

B. Preconstruction Plan Check and Construction Review

1. The Contractor is to ensure that the testing agency is provided with up-to-date Contract Documents and all Contractor submittals related to the Work required by this Section.

2. Provide a preconstruction plan check in accordance with the procedure specified in the referenced standards. Submit a written report of the plan check to the Engineer for review prior to commencement of HVAC Systems installation.

3. Provide periodic construction review during the progress of related HVAC systems installation in accordance with the procedures specified in the referenced National Standards.

C. Pre-TAB Checklist: Prior to the Testing, Adjusting and Balancing (TAB) Work for any HVAC system, submit a completed AABC "Systems Ready to Balance Checklist" to the Engineer for records. The Contractor is to ensure that all work is complete and ready for TAB.

D. Certified Reports: Submit testing, adjusting and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted and balanced in accordance with referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:

1. Draft Reports: Upon completion of testing, adjusting and balancing procedures, prepare draft reports on the approved forms. Organize and format draft reports in the same manner specified for the final reports (drafts may be hand written). Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
2. Final Reports: Upon verification and approval of draft reports, prepare final reports, type written and organized and formatted as specified in Article 2.01. Submit 2 complete sets of final reports.
3. Calibration reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the Project.

1.04 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as the latest edition of all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ASHRAE, American Society of Heating, Refrigerating and Air Conditioning Engineers - Fundamental Handbook, Ch. 13; System and Application Handbook, Ch. 57.
2. SMACNA, Sheet Metal and Air Conditioning Contractors' National Association - Testing, Balancing and Adjusting of Environmental Systems; HVAC Systems.
3. AABC, Associated Air Balance Council - National Standards for Total System Balance.
4. NEBB, National Environmental Balancing Bureau - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems.

B. The testing agency shall be the single source of responsibility to test, adjust and balance the HVAC systems and produce the design objectives.

1.05 SEQUENCING AND SCHEDULING

A. Test, adjust and balance air-conditioning systems before refrigerant systems.

B. Test, adjust and balance air conditioning systems during summer season and heating systems during winter season, including at least a period of operation at outside conditions within 5o F wet bulb temperature of maximum summer design condition, and within 10oF dry bulb temperature of minimum winter design condition. Take final temperature readings during seasonal operation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 REQUIRED DOCUMENTS

A. The Contractor shall provide the following, in a timely fashion, to the test and balance agency: Contract Drawings and applicable Specifications; addenda; change orders; reviewed shop drawings; reviewed equipment manufacturer's submittal data; and reviewed temperature control drawings.

3.02 COOPERATION

A. The Contractor shall cooperate fully with the test and balance agency and provide:

1. Completely operable systems.
2. The right to adjust the systems.
3. Access to system components.
4. Immediate labor and tools to make corrections and repairs, when required, without undue delay.
5. Balancing dampers as required by test and balance agency.

B. The Contractor shall start-up and maintain all heating, ventilating and air conditioning systems and equipment into full operation and shall continue the operation of same during each working day of testing and balancing. Start-up shall include, as a minimum, the following:

1. All equipment operable in safe and normal conditions.
2. Temperature control systems installed complete.
3. Proper thermal overload protection in place for electrical equipment.
4. Air Systems:
   a. Filters clean and in place.
   b. Duct systems clean of debris.
   c. Correct fan rotation.
   d. Fire and volume dampers in place and open.
   e. Coil fins cleaned and combed.
   f. Access doors closed and duct end caps in place.
   g. All outlets installed and connected.
   h. Duct systems leakage shall not exceed the rate specified.

C. If it is determined by the test and balance agency that drive changes are required, the Contractor shall obtain and install all necessary components.

D. The Test and Balance Agency shall cooperate with the Engineer and the Contractor to perform the work in such a manner as to meet the job schedule.

E. The test and balance agency shall leave all system components in proper working order, such as:

1. Replace belt guards.
2. Close access doors.
3. Close doors to electrical switch boxes.
4. Restore thermostats to specified settings.

F. All recorded data shall represent a true, actually measured or observed condition.

G. Any abnormal conditions in the mechanical systems of conditions, which prevent total system balance, as observed by the test and balance agency, shall be reported as quickly as possible to the Engineer.

3.03 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system perform the following steps:

1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return and exhaust) and temperature control diagrams.
3. Compare design to installed equipment and field installations.
4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
5. Replace all system filters .
6. Check dampers (both volume and fire) for correct and locked position and temperature control for completeness of installation before starting fans.
7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.
8. Determine best locations in main and branch ductwork for most accurate duct traverses. Place outlet dampers in the full open position.
9. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.04 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage. Take all measurements in the system where best suited to the task.

1. Instruments shall meet the specifications of the referenced standards.
2. Use only those instruments, which have the maximum field measuring accuracy and are best suited to the function being measured.
3. Apply instrument as recommended by the manufacturer.

B. When averaging values, take a sufficient quantity of readings, which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

C. Take all readings with the eye at the level of the indicated value to prevent parallax.

D. Use pulsation dampeners where necessary to eliminate error involved in estimating averages of rapidly fluctuating readings.

3.05 TESTING, ADJUSTING AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.

1. Cut insulation, ductwork and piping for installation of test probes to the minimum extent possible to allow adequate performance of procedures.
2. Patch insulation, ductwork and housings using materials identical to those removed.
3. Seal ducts and piping, and test for and repair leaks. Seal insulation to re-establish integrity of the vapor barrier.
4. Mark equipment settings, including damper control position, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
5. Retest, adjust and balance systems subsequent to significant system modifications and resubmit test results.

B. Test and adjust mechanical systems for sound and vibration in accordance with the detailed instructions of the referenced standards.

C. Adjust all HVAC systems to deliver the specified air quantities within the following tolerances:

1. Equipment (fans, heat transfer equipment, and air terminal units): ±5%.
2. Air outlets: ±5%.

3.06 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory performances when system cannot be successfully balanced.

3.07 DEMONSTRATION

A. Submit the final TAB report for review along with Contractor's completed checklist of recommendations for correcting unsatisfactory areas identified by testing agency.

B. Pre-test all systems prior to inspection and acceptance tests required by referenced standards. Provide detailed documentation of the referenced standard inspection tests by the Contractor and

include test procedures, participants, dates and times, instruments used, test data and a summation of test results. Submit test reports prior to system commissioning tests conducted by the City.

C. System Commissioning Tests

1. Tests shall demonstrate that capacities and general performance of air systems comply with Contract requirements.
2. At the time of system commissioning, recheck, in the presence of the Engineer, random selections of data (air quantities and air motion) recorded in the certified TAB test report.
3. Selections for checks in general will not exceed 25 percent of the total number tabulated in the report.

D. Train the City's maintenance personnel on troubleshooting procedures and testing, adjusting and balancing procedures. Review with the City personnel the information contained in the Operating and Maintenance Manual.

E. Schedule training with City with at least 7 days prior notice.

3.08 SERVICES

A. Retests: If random tests elicit a measured flow deviation exceeding the specified tolerances, the TAB report will automatically be rejected. In the event the report is rejected, readjust and test all systems, record new data, submit new certified Reports and perform new rechecks at no additional cost to the City; including time required by the Engineer.

B. Reinspection: TAB Agency shall make 2 return inspection trips to the project, one during heating design conditions and one during air conditioning design conditions for the purpose of checking out the entire system or group of systems.

C. Readjustments: Balancing agency shall make additional adjustments required during the reinspection.

END OF SECTION 15990

SECTION 15991
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Centrifugal base-mounted ventilators.
2. Ceiling-mounted ventilators.
3. In-line centrifugal ventilators.

1.02 ACTION SUBMITTALS

A. Product Data:

1. Include rated capacities, furnished specialties, and accessories for each fan.
2. Certified fan performance curves with system operating conditions indicated.
3. Certified fan sound-power ratings.
4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
5. Material thickness and finishes, including color charts.
6. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting seismic restraints.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

B. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

C. UL Standard: Power ventilators shall comply with UL 705.

D. AMCA Compliance: Provide components that meet performance requirements and are licensed to use the AMCA seal.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL BASE MOUNTED VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:

1. Acme Engineering & Mfg. Corp.
2. New York Blower Company
3. Greenheck.
4. Loren Cook Company.
5. Penn Barry
6. Breidert

B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle square, one-piece, aluminum base with venturi inlet cone.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust airstream.

F. Accessories:

1. Disconnect Switch: Explosion-proof rated, nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

2.02 MOUNTING VENTILATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide or a product by one of the following:

1. Acme Engineering & Mfg. Corp.
2. Greenheck.
3. New York Blower Company.
4. Loren Cook Company.
5. Penn Barry.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Aluminum louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:

1. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
2. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
3. Filter: Washable aluminum to fit between fan and grille.
4. Isolation: Rubber-in-shear vibration isolators.
5. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.03 IN-LINE CENTRIFUGAL VENTILATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Acme Engineering & Mfg. Corp.
2. Greenheck.
3. New York Blower Company.
4. Loren Cook Company.
5. Penn Barry.

B. Description: In-line, direct or belt driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Motor mounted in airstream, factory wired to an explosion-proof disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub, non-sparking.

F. Accessories:

1. Backdraft: Manufacturer provided gravity operated, located at fan outlet.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch (13- by 25-mm) mesh of galvanized steel in removable frame. Provide OSHA approved guard for inlet or outlet for units not connected to ductwork
4. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.04 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Totally enclosed, fan cooled and explosion-proof rated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install power ventilators level and plumb.

B. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and spring hangers with vertical-limit stops having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 15 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Division 15 Section "Identification for HVAC Piping and Equipment."

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 15 Section "Air Duct Accessories."

B. Ductwork adjacent to power ventilators shall be installed to allow service and maintenance.

C. Ground equipment according to Division 16 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 16 Section "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
5. Adjust damper linkages for proper damper operation.
6. Verify lubrication for bearings and other moving parts.
7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
9. Shut unit down and reconnect automatic temperature-control operators.

10. Remove and replace malfunctioning units and retest as specified above.

11. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

3.04 REDUNDANCY CONTROL

A. To be in compliance with the NFPA code 820 the exhaust fans for the Diversion and the Jet Mixing buildings must be operational while the pumps are in operation and to be assured of this, 100% redundancy has been provided for both of the buildings. The redundancy for the Diversion building was achieved through (2) wall mounted fans with gravity back draft dampers so that if on fan is de-energized the damper will close and the other fan will be energized and the damper will open, the fan selection will be done by the building control panel. For the Jet Mix building another type of fan had to be utilized and (2) fans were installed in a parallel fashion where the air flow is controlled by a normally closed motor operated damper interlocked with the fan motor, so that when the motor is energized the damper opens allowing air flow and conversely when the fan is de-energized.

END OF SECTION 15991

SECTION 15999
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.

1.02 ACTION SUBMITTAL

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws.
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch Insert dimension thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for

greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Red.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Section 099100 "Painting."

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Domestic Water Piping:
   a. Background Color: Blue.
   b. Letter Color: White.
2. Sanitary Waste and Storm Drainage Piping:
   a. Background Color: Red.
   b. Letter Color: Black

3. Natural Gas:
   a. Background Color: Green.
   b. Letter Color: White
4. Maintenance facility service fluids:
   a. Background Color: Yellow.
   b. Letter Color: Black.

END OF SECTION 15999

SECTION 16000
ELECTRICAL POWER AND SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of all electrical power and systems. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

1.02 DEFINITIONS

A. Provide: Furnish, install, and connect.

B. Product Data: Catalog cuts and descriptive literature.

C. Shop Drawings: Factory prepared specific to the installation.

D. Indicated: Shown on the Contract Drawings.

E. Noted: Indicated or specified elsewhere.

F. Control Diagram: A control diagram shows by means of graphic symbols, the electric connections and functions of a specific circuit arrangement. The control diagram facilitates tracing the circuit and its functions without regard to the actual physical size, shape, or location of the component devices or parts.

G. One-Line Diagram: A one-line diagram shows by means of single lines and graphic symbols the course of an electric circuit or system of circuits and the components, devices, or parts used therein. Physical relationships are usually disregarded.

H. Block Diagram: A block diagram is a diagram of a system, instrument, computer, or program which selected portions are represented by annotated boxes and interconnecting lines.

I. Wiring Diagram: A wiring or connection diagram includes all the devices in a system and shows their physical relationship to each other including terminals and interconnecting wiring in an assembly. This diagram shall be a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or b) a panel layout drawing showing the physical location of devices plus the control diagram.

J. Interconnection Diagram: Interconnection diagrams shall show all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams, which interface to the interconnection diagram. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry/exit of the individual wires clearly shown. Wireless diagrams and wire lists are not acceptable. Each wire identification as actually installed shall be shown. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified. All jumpers, shielding and grounding terminations not shown elsewhere shall be shown here. Signal and DC circuit polarities shall be shown. Spare wires shall be shown.

K. Arrangement, Layout, or Outline Drawings: An arrangement, layout, or outline drawing is one, which shows the physical space and mounting requirements of a piece of equipment. It may also indicate ventilation requirements or the location to which connections are to be made.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Information required "for reference" such as product samples, similar unit test reports, and time current curves is for the purpose of determining the suitability of a product, selecting breaker settings, etc. This information is to be submitted at the same time as approval data; however, this information will not be returned and stamped approval is not required prior to installation.
2. Except as noted, installation instructions are not required to be submitted. However, it is the Contractor's responsibility to obtain installation information from the manufacturer for all equipment prior to installing the equipment.
3. Interconnecting diagrams depicting all cable requirements together with actual terminations as specified under paragraph 16000-1.02J.

1.04 QUALITY ASSURANCE

A. Provide complete electrical installation in accordance with the National Electrical Code (NFPA 70), Life Safety Code (NFPA 101), and in accordance with applicable local codes. Obtain all necessary permits and have all work inspected by appropriate authorities.

B. All products shall be designed, manufactured, and tested in accordance with industry standards. Where applicable, products shall be labeled or listed by third party certification agencies.

C. Industry Standards: Standards organizations and their abbreviations, as used herein, are as follows. Applicable date for industry standards is that in effect on the date of advertisement of the project.

1. American National Standards Institute (ANSI).
2. American Society for Testing and Materials (ASTM).
3. Federal Specifications (FS).
4. Institute of Electrical and Electronics Engineers (IEEE).

5. Insulated Cable Engineers Association (ICEA).
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA).
8. Underwriters Laboratories, Inc. (UL).
9. National Electrical Testing Association (NETA).

1.05 WORK INCLUDED IN DIVISION 16, ELECTRICAL

A. Electrical power and systems.

B. Basic materials and methods.

C. Raceway Systems.

D. Wire and Cable.

E. Boxes.

F. Wiring devices.

G. Electric motors.

H. Cabinets and enclosure.

I. Instrument transformers and meters.

J. Liquid filled secondary substation transformers.

K. Primary power switchgear.

L. Low voltage switchgear.

M. Surge arrestors.

N. Protective relays.

O. Disconnect switches.

P. Grounding.

Q. Dry type transformers.

R. Panelboards.

S. Low voltage motor control center.

T. Large variable frequency drives.

U. Lighting fixtures.

V. Lightning protection.

W. Neutral grounding resistors.

X. Fire alarm system.

Y. Telephone system.

Z. Acceptance testing and calibration.

AA. Access system.

BB. Short circuit and coordination studies.

1.06 MATERIALS AND EQUIPMENT FURNISHED AND INSTALLED UNDER OTHER DIVISIONS WITH RACEWAY AND ELECTRICAL CONDUCTORS FURNISHED, INSTALLED, AND CONNECTED UNDER DIVISION 16, ELECTRICAL

A. Equipment, Instrumentation and control system components indicated on the Drawings by filled circumscribed diamond symbol.

1.07 INTENT OF DRAWINGS

A. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for proper routing of raceway, subject to the approval of Engineer.

1.08 PROTECTIVE COORDINATION STUDY

A. The Contractor shall provide phase and ground fault coordination study to show that the following conditions are met:

1. Utilization equipment and conductor systems are protected from thermal damage.
2. An overload or short circuit will cause operation of the next upstream device and no others.
3. Device operation will not occur on steady state or inrush conditions.

B. Provide five brochures in hard cover 3-ring binders, each including complete protective device coordination study complete with device coordination time-current curves for the medium and low voltage distribution system.

C. After award of the Contract, the Engineer will give the Contractor a list of available 3-phase symmetrical short circuit current at important points throughout the plant and a computer generated list of circuit conductor characteristics (number of phases, number of wires, wire size, number of paralleled conductors, raceway type, circuit length), motor fault contributions, utility fault contribution and circuit topology. Before starting the protective device coordination study the Contractor shall confirm this information and inform the Engineer in writing if any substantial discrepancies are found. The Engineer's corrected fault current list will be the, basis for the coordination study. Values supplied by the Engineer are to be used solely for determination of device settings equipment ratings are as elsewhere noted.

D. In the protective device coordination study, provide time-current curves graphically indicating the coordination proposed for the system, on conventional, full-size, log-log forms, K&E 48-5257, or equal. Include with each curve sheet a complete title and one-line diagram with legend identifying the specific portion the system covered by that particular curve sheet. Include a detailed description of each protective device identifying its type function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and delay settings. Show settings so that they read directly in the unit marked on the adjustment knob; for instance, if a setting is to be 5 times current-tap, the adjustment knob has settings A-F, and setting C corresponds to 5 times, note that setting is "5 X current tap = adjustment knob mark C."

E. Include-on the curve sheets power company relay and fuse characteristics, system medium voltage equipment relay and fuse characteristics, low voltage equipment circuit breaker trip device characteristics, pertinent transformer characteristics, pertinent motor characteristics, and characteristics of other system load protective devices. Include at least all devices down to largest branch circuit and largest feeder circuit breaker in each motor control center and 480-volt panelboard. Include all adjustable setting ground fault protective devices. Include manufacturing tolerance and damage bands in plotted fuse characteristics. For transformers use the manufacturer's thermal three-phase and thermal stress line-to-ground damage curves per ANSI C57.109. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed.

F. Select each primary protective device required for a delta-wye connected transformer so that its characteristic or operating band is within the transformer characteristics, including a point equal to 58 percent of the ANSI withstand point to provide secondary line-to-ground fault protection. Where the primary device characteristic is not within the transformer characteristics, show a transformer damage curve. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by a 16 percent current margin to provide proper coordination and protection in the event of secondary line-to-line faults. Separate medium voltage relay characteristic curves from curves for other devices by at least a 0.4-second time margin.

G. In each binder, include complete sets of individual protective device time-current characteristics on transparencies.

H. Protective device study may be prepared with a network analyzer, digital computer, or by written computations.

I. Provide protective device coordination study carried out by a professional electrical engineer registered in the State of Georgia who is not employed by the Contractor or by an electrical equipment manufacturer. Provide studies prepared by persons experienced in the work. Submit a draft study to Engineer for review. Make all additions or changes as required by the reviewer.

J. Use new equipment load data for the study from Contract Documents, including Contract Addenda issued prior to bid opening. Verification of existing equipment data shall be by Contractor.

1.09 ELECTRICAL NUMBERING SYSTEM

A. Raceway Numbers:

1. Raceways shall be tagged at all terminations where raceway numbers have not been assigned, Contractor shall assign raceway numbers in accordance with the following system:

Raceway Prefix	Type of Function
C	Control and/or 120V or less power
H	Power above 600V
N	Pneumatic tubing
P	Power 208V to 600V
S	Low level signal (less than 90 volt communication or less than 30 volt instrumentation)
X	Spare

2. Prefixes shall be followed by a 5-digit equipment number. Where there is more than one raceway to particular equipment, a letter suffix is added to distinguish the raceways.

3. Example:

Raceway number = P31109A

31109 = unique 5-digit equipment number

A=Letter to distinguish from other raceways to same equipment

B. Conductor Numbers:

1. Conductors shall be identified with numbers at both ends. Conductor tag numbers shall consist of the 5-digit equipment number followed by a dash followed by the conductor number specified on the control diagram.

2. Example:

Tag number = 19000-L1

Where:

19000 = Cable number

L1 = Conductor number

3. Conductors which are in parallel or in series between equipment shall have the same conductor number. Neutral conductors shall have the same conductor number wherever possible, the conductor shall be the same as the terminal to which it connects.

4. When factory-wired equipment has terminal numbers different than the conductor number shown on the control diagram, both shall be shown on the interconnection diagram, and a copy of the interconnection diagram shall be fastened to the inside of the equipment cabinet.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Ship products to the job site in their original packaging. Receive and store products in a suitable manner to prevent damage or deterioration. Keep equipment upright at all times.

B. Investigate the spaces through which equipment must pass to reach its final destination. Coordinate with the manufacturer to arrange delivery at the proper stage of construction and to provide shipping splits where necessary.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Provide only new products of the manufacturer's latest design.

B. Equipment shall be applied only within its rating. Equipment ratings shown are minimums. Voltage and current ratings shall be as required to adequately power the connected equipment. Fault current ratings shall be as shown for the particular item or for the next upstream device that has a fault current rating shown.

C. The following areas are classified hazardous:

1. Pumping station wet well.
2. All underground vaults.

D. The following areas are classified as corrosive:

1. Valve Vaults.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Maintain continuity of electric service to all portions of the process or buildings at all times. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with Engineer and the electric utility company providing service to the facility. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer. Include all costs for temporary wiring and overtime work required in the Contract price. Remove all temporary wiring at the completion of the work.

B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory. Construe nothing in the Contract Documents as permitting work not in compliance with these codes.

C. Unless otherwise indicated, all material required to be removed and salvaged shall become the property of the City.

D. Carefully modify existing electrical equipment, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.

3.02 CERTIFICATION AND TESTS

A. Prior to request for final review, test all systems and repair or replace all defective work. Submit, with request for final review, written certification that all electrical systems are complete and operational.

B. At the time of final review of electrical work, demonstrate the operation of electrical systems. Furnish labor, apparatus and equipment for systems' demonstration.

C. After final review and acceptance, turn over to the Engineer all keys for electrical equipment locks. Present to the City's designated representatives, demonstrations and oral instructions for proper operation and maintenance of the electrical equipment and systems.

D. Provide motors and heater tabulation as requested in Section 01005.

FORM 16000 A
INSTALLED WIRE AND CABLE RESISTANCE TEST DATA FORM

Project _____
Date: _____

Site Conditions: _____

Time: _____

Circuits or Items being tested:

_____

_____

Wire or Cable No.: _____ Temperature, oF: _____

	Location of Test	From	To	Insulation, Resistance, megohms
1.				
2.				
3.				
4.				
5.				
6.				
7.				

Comments:

_____

_____

_____

CERTIFIED _____ _____
Contractor's Representative Date

WITNESSED _____ _____
City's Representative Date

FORM B
INSTALLED MOTOR TEST FORM (PRE-OPERATIONAL CHECK/TEST)

Motor Equipment Number _____ Date of test _____
Equipment Driven _____ Ambient temp _____oF
MCC Location _____

Resistance:

Insulation resistance phase-to-ground megohms:

Phase A _____ , Phase B _____, Phase C _____

Current at Full Load:

Phase Current, amps _____

Phase Current, amps _____

Phase Current, amps _____

Thermal Overload Device: Manufacturer/catalog # _____ Amperes _____

Circuit breaker (MCP) setting: _____

Motor Nameplate Markings:

Mfr _____ Mfr type _____ Frame_____ HP _____
Volts _____ Phase _____ RPM _____ **Service factor _____
Amps _____ Freq _____ Ambient temp rating _____ oC

Time rating _____ **Design letter _____
(NEMA 1-10.35) (NEMA MG-1.16)

Code letter_____ Insulation class_____

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ _____
Contractor's Representative Date

WITNESSED _____ _____
City's Representative Date

END OF SECTION 16000

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS AND DEFINITIONS

A. Drawings, Specifications and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 16.

B. "Drawings" or "Contract Drawings", as used herein, refer to the Project Contract Drawings.

C. "Specifications" or "Contract Specifications", as used herein, refer to the Project Contract Specifications.

D. "Documents" or "Contract Documents", as used herein, refer to the Project Contract Drawings, Specifications, and general conditions and requirements.

E. "Division 16", as used herein, refers to the Project Division of Work and Scope (also referred to as the Electrical Division), comprising the Project requirements intended for the Electrical Contractor's completion. Included are all Electrical Division Drawings and Electrical Division Specifications (16XXX).

F. "Contractor", as used herein, refers to the Electrical Contractor (including his sub-contractors and his electrical / etc., equipment manufacturers and suppliers who provide his equipment), who has responsibility to furnish and install the "Scope of Work", as described herein and per the Contract Documents.

G. "Owner", as used herein, refers to the property owner, proprietor, administrator or agent as defined in the project contractual agreements.

H. "Code", as used herein, refers to all of the applicable regulatory and advisory standards listed herein.

I. "Authority Having Jurisdiction (AHJ)" is defined in the National Electrical Code as "An organization, office or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure".

J. The requirements of this Section apply to the entire Scope of Work including that shown on the Drawings, in the Division 16 Section Specifications, in the General and Supplementary Conditions, and in the Division 1 and other related Specifications.

1.02 SUMMARY

A. This Section includes general, administrative and procedural requirements for electrical installations. The following general, administrative and procedural requirements are included in this Section to expand the requirements specified elsewhere in general Project Specifications and in Division 1:

1. Scope of work.
2. Applicable standards / Quality assurance.
3. Interpretation of Drawings.
4. Priority of contract documents.
5. Submittals.
6. Co-ordination drawings.
7. Record documents.
8. Operation and Maintenance manuals.
9. Materials.
10. Codes, inspections and fees.
11. Delivery, storage and handling.
12. Tests and settings.
13. Manufacturers' services.
14. Size of equipment.
15. Enclosure types.
16. Hazardous areas.
17. Electrical protective device coordination, short circuit and other studies.
18. Warranty.

B. Related Sections: All Division 16 Section Specifications.

1.03 SCOPE OF WORK

A. Furnish all labor, supervision, materials, equipment and incidentals required to make ready for use complete functional electrical systems as shown on the Drawings and specified herein.

B. The work shall include furnishing, installing, interconnecting and testing the equipment and materials specified in all other Sections of the Division 16 Specifications and shown on the Drawings.

C. The work shall include furnishing, coordinating, and installing the following:

1. It is intended that Contractor coordinate with the Electrical Utility Company, to the extent necessary, so that an appropriate, complete and reliable electrical service or supply is provided for this Project. Electrical Utility Company cost charges, for modification and extension of all on-site, Project-related but Utility-required infrastructure installations, materials, improvements, etc, which benefit the project, shall ultimately be borne by Owner. Projects warranting Electrical Utility Company cost charges for off-site Utility infrastructure improvements or modifications shall likewise have such costs ultimately borne by Owner, when required by Utility. However, unless otherwise indicated or negotiated with the Owner, Contractor shall include in his project scope and pricing and bear responsibility for coordination and completion of all requisite work as required by Utility including the following:

a. Project service transformer pad, vault, and / or work to enable / facilitate Utility interface or "point-of-tie-in" interface.

b. Determination and implementation of Utility requirements and details and locations of major equipment, including project service transformer(s).

c. Empty conduit with pull wire or conduit sleeves between project service transformer(s) and Utility primary voltage point-of tie-in, as per Utility.

d. Utility requirements for metering and installation.

e. Complete conduit and wiring and termination of secondary voltage conductors between the project service transformer(s) and the project service entrance equipment.

f. Concrete encasement of primary conductors when required by Utility and / or called for on the Contract Drawings.

g. Concrete encasement of project service transformer(s) secondary, where required and /or called for on the Contract Drawings.

h. Utility required fencing, bollards, grounding, signage and all miscellaneous appurtenances.

i. Contractor shall include all costs for items tabulated above and appurtenant items related to Electric Utility Company service or supply, in his scope, cost estimates, bids, etc. Intent is that these costs, to the extent applicable, be passed from Utility, through Contractor (as project costs), to Owner as part of the electrical subcontract bid price and subsequent payment requests.

    i) Unless specified otherwise, complete, functional, fully installed, interconnected and tested systems for power, control, lighting, grounding, telephone, data, fire alarm, communications, signaling, security, lightning protection, electrical heat tracing of piping, etc. as indicated in other Sections of Division 16 and as shown on the Drawings are included in Division 16 scope.

    ii) Conduit, wire, field connections and installation for all motors, motor controllers, control devices, control panels, and "packaged" equipment furnished under other Divisions of these Specifications are included in Division 16 scope.

    iii) Installation, mounting and field wiring for all field-mounted devices and instruments, furnished under other Divisions and / or Sections of these Specifications, which require on-site electrical and / or electronic wiring supply / terminations. All conduit, wire, and interconnections between devices, primary elements, transducers, transmitters, relays, transformers, indicators, sensors, switches, alarms, control panels, etc. are included in Division 16.

    iv) A complete raceway system for all special and / or system cables furnished by electronic system suppliers, process instrumentation suppliers and process control system suppliers. Review the raceway layout with Supplier and the cable manufacturer, prior to installation, to insure raceway compatibility with the systems and materials being furnished.

    v) Installation of all control panels, controllers, etc. furnished under other Divisions and / or Sections of these Specifications.

    vi) Nominal 110-120 volt or greater power service, power supply, power wiring and appropriate conduit or raceway for all equipment and devices utilizing or requiring such power including power for heating, ventilating, air conditioning, (HVAC), mechanical and/or plumbing equipment and appurtenances furnished under other Divisions of these Specifications. Include power wiring for all air handlers, fans, condensing units, heat pumps, heaters, heat tracing, unit heaters, pumps, powered

induction units (PIUs), terminal units, fan coil units, variable air volume units (VAVs), dampers, louvers, motorized operators, valves and any and all other similar HVAC, mechanical and/or plumbing equipment. Include power wiring for all such equipment covered by the Division 15 Drawings and /or Specifications. Provide power wiring and conduit from power source to equipment physical locations and provide wiring terminations as required. Unless noted otherwise, excluded from Division 16 responsibility are conduit and wiring for Division 15 furnished or other similar "HVAC Controls", "Building Management Systems (BMS)" and "Sequence of Operations" controls and systems that require / operate at only "low" voltage (below 110-120 volt nominal) and that do not require 110 - 120 volt or greater power service. See applicable Sections of Division 15 or for reference.

vii) A complete conduit or raceway system with nominal 110-120 volt or greater power wiring for all electronic/ technology and similar system devices and units requiring such supply power from the building infrastructure. Such electronic/ technology systems will be furnished under separate Divisions of the Specifications, unless noted otherwise.

viii) A complete empty raceway system with pull wire for power-limited / low voltage (12V, 24V, 48V, etc.) control, signaling, data highways, fiber-optic systems, etc., related to all electronic / technology and similar systems and devices, shall be furnished and installed by Div.16. The supply, installation and termination of such systems and devices and their required wiring shall be under separate Divisions of these Specifications, unless noted otherwise. Review the raceway layout with Supplier and the cable manufacturer, prior to installation, to insure raceway compatibility with the systems and materials being furnished.

ix) Contractor shall review the submittal / shop drawings for all electrically operated and electrically connected equipment being furnished under all other divisions of these specifications. Unless specified otherwise, Contractor shall provide raceway, wire and interconnection for all materials, devices, components, systems and packages requiring "field wiring", to the extent clarified in the preceding paragraphs. Where applicable, Contractor shall make electrical interconnections per manufacturer's requirements. This includes, but is not limited to, devices that are parts of "packages" but which are shipped separately and require field inter-connection. Also, Contractor shall identify terminals and prepare drawings or wiring tables to extent necessary to enable interconnections.

x) Electrical power utility, conduit, wiring, and wiring termination for all special equipment furnished under other Divisions. Included in Division 16 are electrical supply pumps, site utilities, grounds maintenance equipment, and similar equipment.

xi) Demolition, where / as required.

D. It is the intent of these Specifications that the electrical system shall be suitable in every way for the service required. All material and all work which may be reasonably implied as being incidental to the work of this Section or other applicable sections shall be furnished at no extra cost.

E. Where applicable, the Contractor or his authorized representatives shall, before preparing his proposal, visit all areas of the existing site, buildings and structures in which work under this section is to be performed and inspect carefully the present installation. The submission of the proposal by this Contractor shall be considered evidence that he or his representative has visited

the buildings and noted the locations and conditions under which the work will be performed and that he takes full responsibility for a complete knowledge of all factors governing his work.

F. Where applicable, all power interruptions to existing equipment shall be at the Owner's convenience with 72 hours (minimum) notice. Each interruption shall have prior approval.

G. Where applicable, the Contractor shall maintain the existing facility in operation at all times.

H. Temporary power connections as required shall be provided by the Contractor at no additional expense to the Owner. All temporary wiring shall be in accordance with the NEC. All temporary equipment wiring shall be installed in conduit. The Contractor shall provide to the Engineer details, methods, materials, etc. prior to making temporary connections. Furnish and install all equipment and materials including control equipment, motor starters, branch and feeder circuit breakers, panelboards, transformers, etc., for temporary power. Remove temporary installations prior to / at job completion.

I. The work shall include complete testing of all equipment and wiring at the completion of work and making any minor correction changes or adjustments necessary for the proper functioning of the system and equipment. All workmanship shall be of the highest quality; substandard work will be rejected.

J. Where applicable, identify and verify field conditions of all existing underground structures and utilities, including electrical and mechanical piping.

K. The Contractor shall have the Manufacturer of the major electrical components (per Paragraph 2.01) provide a coordination and short circuit study as specified herein. Contractor shall set all protective devices and relays as specified in Paragraph 1.19.

L. Where applicable, provide all electrical work associated with the relocation of equipment for the existing and new facilities, including disconnection of all existing wiring and conduits and provision of new wiring from the point of electrical supply and conduit to the relocated equipment.

M. Excavation and backfilling, including gravel or sand bedding for underground electrical work is included in Division 16.

N. Concrete work, including concrete electrical duct encasement and electrical equipment and light pole foundations and pads, is included in Division 16.

O. Contractor shall provide all work for duct banks, including but no limited to excavation, concrete, conduit, reinforcement, backfilling, grading and seeding. All work shall be in accordance with Divisions 2 and 3 of these specifications.

P. Complete coordination with other contractors. Div. 16 Contractor shall coordinate with other contractors regarding each-others equipment and equipment submittals and shall obtain all relevant submittals.

Q. Complete electrical heat tracing system for all piping which is indicated as electrically traced on the project Piping & Instrumentation Diagrams and/or Project Mechanical Drawings / Specifications. Contractor shall employ the services of an approved heat-tracing product manufacturer to design the system, using a certified manufacturer developed electronic based

program. System shall protect piping and appurtenances against freezing, or shall maintain temperatures, as required. System shall include code-compliant, environmentally suitable and properly sized self-regulating heat tracing cables, and all related requisite power source and control equipment, panels, transformers, circuitry, contactors, controls, etc. necessary for a complete and functional heat tracing system. Installation shall be by Contractor.

R. Complete coordination with the Electrical Utility Company. Contractor shall complete applicable Utility forms and comply with and respond to Utility requests for information. Such are as related to, but not limited to, sizes and types of new electrical loads, existing loads to remain, existing loads to be deleted, anticipated load diversity/ demand, generators, and size, rating and characteristics of Owner's new and existing electrical equipment, etc., to the extent required by the Utility Company. Intent is that Utility Company will, from such coordination with Contractor, be able to finalize Utility's incoming electrical service ratings and details, service transformer(s) ratings and details, and proper interconnection with Owner's equipment.

S. Seismic Requirements:

1. Conform to the requirements indicated on the structural and other Contract Documents, where applicable.
2. It shall be the responsibility of the equipment manufacturers and suppliers along with the Contractor to conform to the seismic design requirements based on the Project's seismic classification and/or the Contract Documents.
3. All electrical raceways and equipment shall utilize earthquake resistant supporting systems as required by the Project's seismic classification and/or the Contract Documents.
4. Electrical distribution and power control equipment shall be labeled by the equipment manufacturer as "seismic qualified". This labeling shall be indicative that representative samples of the same equipment have been tested and found to meet or exceed the seismic requirements of the I.B.C., U.B.C. and C.B.C. codes and relevant parts of the NFPA codes for the applicable project seismic classification. Contractor shall install such equipment in accordance with these codes and the manufacturer's recommendations. Equipment seismic labeling applies to panelboards, switchboards, motor control centers, busway, transfer switches, switchgear, network protectors, transformers, power centers, metal enclosed switchgear, metal clad switchgear, loadcenters, safety switches, enclosed control assemblies, and generators and generator fuel delivery and storage systems.

T. Interface with the services provided by the Telephone, Data and other Systems Utility Companies / Service Providers. Unless indicated otherwise, furnish and install 4 foot x 8 foot x ¾ inch painted plywood backboard at designated location within the site and two- 4 inch underground non-metallic conduits with pull-wire between the backboard and each point of interface as directed by the applicable Telephone or other Systems' Utilities.

U. Complete testing, as specified.

1.04 APPLICABLE STANDARDS / QUALITY ASSURANCE

A. All electric equipment, materials, and installation shall be in accordance with the National Electrical Code (NEC) and with the latest edition, adopted by the Authorities Having Jurisdiction, of all codes and standards of the following organizations:

1. National Fire Protection Association (NFPA), including (but not limited to):
   a. National Electrical Code (NEC), NFPA 70
   b.
   c. National Fire Alarm Code, NFPA 72
   d.
   e. Life Safety Code, NFPA 101
   f.
   g. Emergency and Standby Power Systems, NFPA 110
2. American National Standards Institute (ANSI), including (but not limited to):
   a. National Electrical Safety Code, ANSI C2
3. Occupational Safety and Health Act (OSHA)
4. Federal Communication Commission (FCC)
5. National Electrical Manufacturers Association (NEMA)
6. Insulated Cable Engineers Association (ICEA)
7. Institute of Electrical and Electronics Engineers (IEEE)
8. National Electrical Testing Association (NETA)
9. American Society of Testing and Materials (ASTM)
10. Illumination Engineering Society of North America (IESNA)
11. Anti-Friction Bearing Manufacturers Association (AFBMA)
12. Building Officials and Code Administrators International, Inc. (BOCA)
13. International Code Council (ICC):
    a. International Building Code (IBC)
14. Uniform Building Code (UBC)
15. International Conference of Building Officials (ICBO)
16. International Energy Conservation Code (IECC), endorsed by the U.S. Department of Energy (DOE)
17. Combined ANSI / ASHRAE / IESNA Standard 90.1- 2010 "Energy Standard for Buildings Except Low-Rise Residential Buildings".
18. National Electrical Contractors Association Installation Standards (NECA)
19. All applicable state and local codes, amendments, regulations and practices

20. All applicable regulatory requirements and advisory practices of appropriate Authorities Having Jurisdiction (AHJs). Note that projects in the state of Georgia are subject to the following:
    a. Georgia Amendments to the IBC and IECC.
    b. Georgia Amendments to the NEC.
    c. Georgia State Minimum Fire Safety Standard Document 120-3-3.
21. All applicable standards, regulations and practices of the Owner.

B. Where codes and/or standards conflict, the most conservative document shall be followed.

C. OSHA Statute Part 29 CFR1926.403(a) requires that "All electrical conductors and equipment shall be approved". Acceptable evidence includes approval or listing by a qualified testing agency. Accordingly, all electrical conductors and equipment shall bear the appropriate Underwriter's Laboratories Inc. (UL), or other Nationally Recognized Testing Laboratory (NRTL) listing mark or classification marking. Equipment, materials, etc. not bearing a supplier provided UL or NRTL certification shall be field certified by UL or NRTL (or by other method satisfactory to the AHJ) prior to equipment acceptance and use.

D. The portion of work requiring interface with any and all utility companies, service providers, etc. shall be in accordance with their codes, regulations, requirements, etc.

E. Projects including wastewater treatment and / or collection are subject to the latest applicable revision of NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 INTERPRETATION OF DRAWINGS

A. Electrical loads (KVA, KW, Horsepower, Amperes, etc.) and wiring requirements indicated on the electrical Drawings are estimates representative of standard mechanical and building equipment. Electrical equipment ratings, bus ratings, circuit wire sizes, circuit wire quantities, conduit sizes, conduit quantities and overcurrent protection device ratings indicated on the Drawings are based on such equipment. Contractor is advised that prior to installation he must compare indicated electrical equipment ratings, wire sizes and quantities, conduit sizes and quantities and overcurrent protective device ratings versus approved shop drawings of actual equipment being furnished. Contractor shall provide electrical materials conforming to the requirements of the actual equipment being furnished, reflecting increased ratings, wire sizes and quantities, conduit sizes and quantities and overcurrent protective device ratings where required to match shop drawings. Overcurrent protective device ratings shall be decreased if required to match actual equipment requirements and/or manufacturer's recommendation. Other electrical ratings, wire sizes and quantities and conduit sizes and quantities shall not be decreased to less than that indicated on the electrical Drawings.

B. Equipment short circuit interrupting and/or withstand ratings are indicated on the Drawings and/or Specifications. These ratings equal or exceed design Engineer's determination of approximate short circuit levels based on standard data available at the time of design. Such determinations often assume "worst condition" situations and allow for unknown / unavailable / unreliable data at time of design. Such data typically includes Utility Company available fault

levels, service transformer ratings, type, location, etc. Also note that Engineer's design may indicate equipment with higher ratings than required by specific application, in cases where there is a desire for standardization of equipment throughout the Project. Contractor shall furnish equipment meeting these indicated ratings or shall furnish higher rated equipment if and when required based on the results of the Short Circuit Study (see Section 1.19). Advise Engineer and request clarification in such situations. In no case, shall equipment with ratings lower than those indicated on the Drawings and/or specified (per design Engineer's determined values) be permitted.

C. Unless otherwise approved by the Engineer, conduit shown or specified exposed shall be installed exposed; conduit shown or specified concealed shall be installed concealed.

D. Where circuits are shown as "home-runs", all necessary fittings and boxes shall be provided for a complete raceway installation.

E. Verify with the Engineer the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

F. Any work installed contrary to or without approval by the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.

G. The Drawings are not intended to show exact locations of equipment or conduit runs. The locations of equipment, fixtures, outlets, and similar devices shown on the Drawings are approximate only. Exact locations shall be as determined in field by Contractor, during construction, after coordination with the Owner and /or his designated representative and approval by the Engineer. Obtain in the field all information relevant to the placing of electrical work, and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

H. Surface mounted panel boxes, junction boxes, conduit, etc., shall be supported by spacers (minimum 1/2 inch) to provide a clearance between wall and equipment.

I. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting, and other electrical systems shown. Additional circuits shall be installed wherever needed to conform to the specific requirements of equipment.

J. All connections to equipment shall be made as required, and in accordance with the approved shop and setting drawings.

K. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment, and/or layout other than specified herein, shall be done by the Contractor at his own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his own or others, caused by such redesign.

L. The Contractor shall coordinate his work with the work of the different trades so that interferences between conduits, piping, equipment, architectural and structural work will be avoided. All necessary offsets shall be furnished so as to take up a minimum space and all such offsets, fittings, etc., required to accomplish this shall be furnished and installed by the Contractor

without additional expense to the Owner. In case interference develops, the Engineer is to decide which equipment, piping, etc., must be relocated, regardless of which was installed first.

M. Where installation of new, active, conduit runs are called for or indicated in the Contract Documents, in locations which will become "inaccessible" after installation is complete, (such as underground, or in concrete encasement, or in concrete slabs, or similar application), Contractor shall furnish and install spare conduits of similar type and size, for the entire "inaccessible" part of such conduit runs. The quantity of additional spare conduits shall be such that the number of additional spare conduits (or, with Engineer's approval, the cumulative cross sectional area) shall be equivalent to 20% or more of the active conduits. Such spare conduits will generally not appear on the Drawings, but shall be included.

N. Conduits and cables called for or indicated per the Contract Documents as having 8 or more installed control wires, shall be supplemented by Contractor to include 20% additional spare control wires. Where such additional wires require increase in conduit size, Contractor shall furnish and install larger conduit. Such spare wires will generally not appear on the Drawings, but shall be included.

O. Dimensions indicated on the Drawings related to electrical equipment locations and /or clearances (relative to walls, column lines, other equipment, etc) are generally minimum clear dimensions to be maintained as per Code, AHJ, Project and / or operating requirements. Such dimensions shall be maintained or exceeded, but not reduced, regardless of actual equipment sizes which will only be determined after approval of project specific manufacturer's drawings. Concrete pads, vaults, structures, etc for electrical equipment, where dimensioned on the Drawings, are estimated dimensions based on typical catalog sizes of electrical equipment on which the design is based. Such dimensions shall be adjusted by Contractor if / as necessary based upon project specific approved manufacturer's drawings.

P. Conduit and wiring between electrical "field" utilization equipment, loads, motors, instrumentation, etc. and their respective "source" switchgear, motor control center, panelboard, PLC, termination cabinet, etc. are generally shown on the Drawings as "homeruns". Similarly, conduit and wiring between panels are shown as "homeruns". Contractor's scope, under this Section, shall include determination of the most suitable physical routing of such "homeruns", considering Owner preferences, building layouts, existing conditions, ease of installation, interferences, etc. Where multiple "homeruns" of instrumentation "digital control (120 VAC)" or "analog control (4-20 mA DC)" wiring run from the same "field" location or from the same panel to the same "source" location, Contractor may combine multiple wiring circuits into larger (common) conduits so as to provide an economical and practical installation. However, "digital" and "analog" wiring shall not share the same (common) conduits with each other. Contractor shall not combine power wiring into larger (common) conduits except in limited situations as specifically allowed by the Contract Documents. Contractor shall prepare Coordination Drawings (per this Spec.) clearly indicating "homerun" routing and combining of multiple wiring into common conduits, as permitted, for Approval before execution of the installation.

Q. Overall underground electrical ductbanks are generally shown on the electrical site plans. Final stub-up locations (entry/exit) into equipment inside electrical rooms and at each site area shall be field coordinated and determined by Contractor.

R. Equipment drawings shall be used to determine where embedded conduits may be stubbed- up at or beneath equipment. For all embedded conduits, Contractor shall determine routing of conduit based on site conditions.

S. Conduits embedded in concrete slab shall not interfere with equipment or building structures. Interferences with embedded conduits stubbed-up up at or beneath equipment shall also consider accessibility at such equipment. Interferences with embedded conduits shall be the Contractor's responsibility and cost to remedy.

T. Spare empty conduits shall be installed embedded in slabs as required, and as part of underground ductbanks according to Division 16 specifications.

1.06 PRIORITY OF THE CONTRACT DOCUMENTS

A. If during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and Drawings, furnish the higher performance requirements. The higher performance requirements shall be considered the equipment, material, device or installation method that represents the most stringent option, the highest quality, or the largest quantity.

B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.

C. Detailed drawings shall govern over general drawings; larger scale drawings take precedence over smaller scale drawings; change order drawings shall govern over Contract Drawings. Contract Drawings shall govern over shop drawings. Once submittal / shop drawings have cleared the submittal review process, they shall be used as documents complementary to and supportive of the Contract Drawings. Should a shop drawing that has been through the submittal review process contain a conflict, omission and / or error, contrary to the Contract Drawings and / or Contract Documents, so as to void or diminish the original intent of the Contract Drawings and /or Contract Documents, the Contract Drawings and / or Contract Documents shall govern.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provision of the Contract Documents will take precedence if they are more stringent or cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between laws and regulations, the higher performance requirements shall be binding on the Contractor, unless otherwise directed by the Engineer.

E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time, nor limit in any way the Contractor's responsibility to comply with all Laws and Regulations at all times.

1.07 SUBMITTALS

A. Submit, in accordance with the General Conditions, and the Special Conditions, copies of all materials required to establish compliance with the Contract Documents. Submittals shall include at least the following:

1. Switchgear.
2. Switchboards and Panelboards.

3. Medium Voltage Motor Control Centers.
4. Low Voltage Motor Control Centers.
5. Variable Frequency Drives
6. Transformers.
7. Reduced Voltage Starters.
8. Lighting Fixtures and Lamps.
9. Manholes, Pullboxes and Handholes, Frames and Covers.
10. Grounding Hardware and Connections.
11. Raceways, Boxes, Fittings and Hangers.
12. Wires and Cable.
13. Switches, Receptacles and Covers.
14. Lightning Protection System.
15. Fire Alarm System.
16. Acceptance Testing Plan.
17. The Manufacturer's name and product designation, catalog number and serial number shall be submitted for all electrical and grounding testing equipment utilized.

B. When a resubmittal is required the Contractor shall submit all previously accepted material in addition to the corrected or added information. It is intended that each resubmittal be a complete and stand- alone document.

C. Prior to submittal, all Submittal shop drawings shall be checked for accuracy and Contract requirement conformance. Submittal shop drawings shall bear the date checked. In addition each Submittal shall include a copy of the applicable specification section, including addendum updates, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated and, therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. The submittal shall be accompanied by a detailed, written justification for each deviation. Failure to include a copy of the marked-up specification sections, along with justifications for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

D. Upon receipt of a Submittal, a review will be conducted. This review will be limited to general assessment of Submittal's conformance to the Project's design intent and general compliance with the Contract Specifications and Drawings. The review will not change the requirements of the Contract Documents, nor shall this review relieve the Contractor of responsibility for non-conformances or errors in the Submittal. The responsibility of, or the necessity of, furnishing materials and workmanship required by the Specifications and Drawings, which may not be indicated in the shop drawings, is included as work under this Section. In no case will the Submittal review process include review of submitted fixture / outlet / fittings and similar commodity quantities nor wire / raceway and similar material lengths, etc.

E. The responsibility for all dimensions to be confirmed and correlated at the job site and for coordination of this work with the work of all other trades is also included under the work of this Section.

F. No material shall be ordered or shop work started until approval of shop drawings has been given.

G. In addition to Manufacturer's equipment shop drawings, the Contractor shall submit for review electrical coordination/installation working drawings. See Paragraph 1.08

H. Submit Record Documents. See Paragraph 1.09

I. Submit Operation and Maintenance Manuals. See Paragraph 1.10

1.08 COORDINATION DRAWINGS

A. Prepare electrical coordination/installation working drawings to scale of 1/4" = 1'-0" or larger, detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access, and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of all raceway systems, equipment, and materials. Include the following:
   a. Size of equipment and clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.
   b. Exterior wall and foundation penetrations.
   c. Fire-rated wall and floor penetrations.
   d. Equipment connections and support details.
   e. Sizes and location of required concrete pads and bases.
   f. Sizes and locations of man-holes, hand-holes, pull boxes, etc.
2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings, and their relationship to other penetrations and installations.
4. Particular attention shall be directed toward concealed and buried conduit layouts. The drawings shall be prepared based on approved equipment shop drawings and shall accurately locate and dimension all conduit stub-ups. Contractor shall assure that no concrete floors or walls are poured until such layouts are approved.
5. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communications systems components, and other ceiling-mounted devices.

B. These coordination drawings shall be prepared by Contractor and submitted by Contractor for conceptual review by Engineer prior to installation by Contractor. Contractor shall be responsible for accuracy of the coordination drawings.

1.09 RECORD DOCUMENTS

A. Contractor shall maintain one set of Contract Drawings in the field, which shall be marked as "Record Drawings". This set of Drawings shall be edited / red-lined by Contractor on a regular basis to indicate all modifications. This set of Drawings shall be available for review by Owner, Engineer, etc.

B. At milestone of substantial project completion, or at alternate date as directed, prepare record documents, using original Contract Drawings in electronic version as a template, to indicate installed modifications for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
2. Equipment locations (exposed and concealed) dimensioned from prominent building lines.
3. Approved substitutions, contract modifications, and actual equipment and materials installed.
4. Record power one line diagrams, panel schedules, control diagram and fire alarm riser diagrams.
5. Unless otherwise noted, Contractor shall provide such Drawings, completely drafted in electronic format, with all installed modifications made clearly distinguishable from original design. This shall be done by use of "clouding" and "numbered triangles" for drafted revisions.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Prepare operation and maintenance manuals include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

B. Operation and Maintenance Data

1. Submit complete operations and maintenance data for all equipment furnished under this Division. The manuals shall be prepared specifically for the installation and shall include all required cuts, drawings, equipment lists, descriptions, complete parts list, etc, that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.11 MATERIALS

A. The materials used in all systems shall be new, unused and as hereinafter specified. All materials where not specified shall be of the very best of their respective kinds. Sample of materials or Manufacturers shall be submitted for approval as required by the Engineer.

B. All current carrying cables, wires, buses, terminals, windings, parts, etc. shall be copper.

C. Equipment shall be suitable in all ways for the intended application. Ratings shall match or exceed the requirements of the indicated Reference Standards, Drawings and Specifications. Electrical short circuit interrupting ratings shall meet the requirements of NEC Article 110. Additionally, electrical equipment shall have fully rated interrupting ratings; equipment having certified "series" rated interrupting capabilities from the manufacturer shall not be considered as acceptable, unless prior written approval is received from the Engineer.

D. Electrical equipment shall at all times during construction be adequately protected against mechanical damage, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to cabinets, panelboards, motor control centers, switchgear, control panels and other similar equipment shall be kept closed at all times when work on them is not being done. Switchgear, motor control center, panelboards and similar Electrical equipment shall not be stored out-of-doors. Such Electrical equipment shall be stored in dry permanent shelters. If any apparatus has been subject to possible injury by water, it shall be replaced at no additional cost to the Owner, the damaged units or systems shall remain on site and returned to the manufacturer after the replacement units or systems have been delivered to the site. Under no circumstances will electrical equipment damaged by water be rehabilitated or repaired, new equipment shall be supplied, and all costs associated with replacement shall be borne by the Contractor.

E. Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted per the field painting specification, at no additional cost to the Owner.

1.12 CODES, INSPECTIONS AND FEES

A. All equipment, materials, procedures and installation shall be in accordance with the requirements of all Authorities Having Jurisdiction, including federal, state and local Authorities and Owner-representative Authorities Having Jurisdiction.

B. Contractor shall obtain all necessary forms, permits, inspections, certificates of acceptance, certificates of occupancy, etc. Contractor shall complete all forms and pay all fees related to these items. Contractor shall submit to the appropriate Authority Having Jurisdiction all necessary documentation, including Drawings, calculations, load summaries, safety plans, work execution plans, schedules, etc., all in the format and quantity as required by the governing Authority Having Jurisdiction. These permits, inspections, and certificates shall cover all aspects of the electrical systems, including the fire alarm system. The permits, inspections and certificates shall be obtained by Contractor from the appropriate Authority Having Jurisdiction including, but not limited to, building departments, inspection authorities, plan review examiners, fire marshals, insurers, utility suppliers, etc.

C. Obtain required inspection stickers indicating installation suitability from appropriate Authorities Having Jurisdiction. Install as directed by Authorities Having Jurisdiction.

1.13 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Inspect products for completeness and conditions; if it is to be stored, reseal for protection; unpack and handle equipment in accordance with manufacturer's recommendations.

C. Store products in dry spaces, free from corrosives. Heat storage areas to prevent condensation, and dust free. Keep equipment clean by covering or by other measures as necessary. Store shipping sections on level surfaces.

D. Store equipment and material under cover, and off the ground or floors exposed to rain.

E. For outdoor storage, protection covers of 10 mil thick black sheet plastic shall be fitted. Covers shall be reinforced to withstand wind and precipitation. Set materials on skid or platforms of height to avoid damage or deterioration from spattering and ground waste.

1.14 TESTS AND SETTINGS

A. Test all systems furnished under Division 16 and repair or replace all defective work. Make all necessary adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

B. Complete all work as detailed in project Specification "Acceptance Testing and Calibration".

C. Make the following minimum field tests and checks. Where possible, make tests and checks prior to energizing electrical equipment. Tests shall be in accordance with manufacturer's requirements and suggestions, industry standards (NETA, or other standard referenced) and with the requirements outlined in the specific Sections of these Specifications:

1. Mechanical inspection, testing and setting of all circuit breakers, disconnect switches, motor starters, control equipment, etc. for proper operation.
2. Test grounding system.
3. Test switchgear and switchboards.
4. Test fire alarm system.
5. Test motor control centers.
6. Test transformers.
7. Test wires and cables.
8. Test substations and protective relaying.
9. Test variable frequency drives / controllers
10. Check all wire and cable terminations. Verify to the Engineer connections meet the equipment's torque requirements. Verify control wire continuity via bell / buzzer test. Megger all power wire and cable. Record all results.
11. Field set all transformers taps as required in order to obtain the proper secondary voltage.

12. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.

13. Check the ampere rating of all thermal overloads for motors and submit a typed record to the Engineer of same, as well as locations and designations, listing the nameplate service factor, horsepower, and full load current. If inconsistencies are found, new thermal elements shall be supplied and installed by this Contractor.

14. Check rotation of all motors, obtain permission from the Engineer to start the motors, and proceed to check it for proper rotation. If it rotates in the wrong direction, correct the rotation at the motor. Take all necessary precautions not to damage any equipment.

15. Carefully check interlocking, control and instrument wiring for each system, and/or part of a system to ascertain that the system will function properly and as indicated by schematic and wiring diagrams where applicable.

16. Provide all instruments, personnel and equipment required for the tests specified herein.

D. All testing shall be scheduled and coordinated by the Contractor. Notify the Owner at least two (2) weeks in advance of conducting tests. The Contractor shall have qualified personnel present during all testing.

E. The following additional tests and checks shall be made prior to the energizing of electrical equipment. Contractor shall engage the services of an independent testing firm. Tests shall be conducted by the independent testing firm, and a certified test report shall be submitted stating that the equipment meets and operates in accordance with the manufacturers and job specifications, and that equipment and installation conforms to all applicable standards and specifications:

1. Testing of protective relays for calibration and proper operation.

2. Over potential, high potential, insulation resistance, and shield continuity tests for cables.

3. Mechanical inspection of switches and circuit breakers to assure proper operation.

F. Three (3) copies of certified test reports shall be furnished to the Engineer for all tests.

G. Contractor shall be responsible for supply of all electrical equipment, components, systems, and qualified manpower, as applicable, to provide for and execute complete electrical testing, system testing and acceptance testing and calibration as specified in the Contract Documents and / or as required. Include testing submittal preparation, testing plan, scheduling, start-up procedures, functional testing, attendance at meetings, testing results recording and documentation, demonstration and training, operations and maintenance manuals, and project close out data (bonds, warranties, spare parts, record documents and maintenance service agreements).

H. Set all relays, protective devices, breakers, etc. in accordance with findings and recommendations of the Electrical Protective Device Coordination Study and of the equipment manufacturer.

I. Infra-red hot spot inspection shall be made of all switchgear, switches, power and control panels. This shall be done under representative load conditions before the equipment is used by the Owner and again three (3) months before expiration of the one (1) year warranty period.

1.15 MANUFACTURER'S SERVICES

A. Provide Manufacturer's services for testing and start-up of the following equipment:

1.	Main MV Switchgear	Minimum three (3) days, two (2) trips.
2.	Unit Substations	Minimum three (3) days, two (2) trips.
3.	Low Voltage Motor Control Centers	Minimum three (3) days, two (2) trips.
4.	MV Load Interrupter Switchgear	Minimum two (2) days, two (2) trips.
5.	VFDs	Minimum one (1) day, one (1) trip.
6.	Reduced Voltage Solid State Starters	Minimum one (1) day, one (1) trip.
7.	Transformers	Minimum one (1) day, one (1) trip.
8.	Switchboards	Minimum one (1) day, one (1) trip.
9.	Fire Alarm Systems	Minimum two (2) days, two (2) trips.
10.	Generators and Transfer Switches	Minimum one (1) day, one (1) trip.

B. The Manufacturers of the above listed equipment shall provide an experienced Field Service Engineer to accomplish the following tasks:

1. The equipment shall be visually inspected upon completion of installation and prior to energization to assure that wiring is correct, interconnection complete and the installation is in compliance with the Manufacturer's criteria. Documentation shall be reviewed to assure that all Drawings, operation and maintenance manuals, parts list and other data required to check out and sustain equipment operation is available on-site. Documentation shall be red-lined to reflect any changes or modifications made during the installation to assure correct type and quantity.
2. The Field Service Engineer shall provide engineering support during the energization and check-out of each major assembly. They shall perform any calibration or adjustment required for the equipment to meet the Manufacturer's performance specifications.
3. Upon satisfactory completion of equipment test, they shall provide engineering support of system tests to be performed in accordance with Manufacturer's test specifications.
4. Three (3) four (4) hour training sessions (one for each system) on operation, and three (3) four (4) hour training sessions (one for each system) on maintenance and trouble-shooting procedures shall be provided for the Owner's maintenance personnel. All training shall be conducted at a facility provided by the Owner. The maintenance and trouble-shooting sessions shall be conducted with record "as-built" electrical drawings sufficient for a class of eight (8) personnel.
5. A final report shall be written and submitted by Contractor to the Engineer within fourteen (14) days from completion of final system testing. The report shall document the inspection and test activities, define any open problems and recommend remedial action.
6. A certificate of proper installation shall be issued by the manufacturer of the following equipment:
   a. Switchgear.
   b. Switchboards.
   c. Motor control centers.

d. Transformers.

e. Variable speed drives / controllers

f. Fire alarm system.

g. Any other equipment as required by the Engineer.

1.16 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, the manufacturer shall be required to ship his material in sections sized to permit passing through such restricted areas in the structure.

B. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passing through such restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.17 ENCLOSURE TYPES

A. Unless otherwise specified herein or shown on the Drawings, electrical enclosures shall have the following ratings.

1. NEMA 1 for dry, non-process indoor locations.
2. NEMA 12 for locations subject to "DUST".
3. NEMA 4X for outdoor locations, rooms below grade (including basements and buried vaults), "DAMP" and "WET" locations. Enclosure material shall be stainless steel or carbon steel with baked or electrostatically applied enamel finish. NEMA 3R may be substituted outdoors only where specifically indicated on the Drawings.
4. NEMA 4X for "CORROSIVE" locations. Enclosure material shall be stainless steel or fiberglass reinforced polyester.
5. NEMA 7 (and listed for use in the area classifications shown) for "Class I, Division 1" and "Class I, Division 2" Hazardous Locations. Enclosure material shall be cast malleable iron.

1.18 HAZARDOUS AREAS

A. All equipment, materials, and installation techniques used in areas designated as hazardous in the Specification Sections, or on the Contract Drawings shall be in strict accordance with National Electrical Code Articles 500, 501, 502 and 503.

B. All equipment and materials used in hazardous areas shall be UL listed for the appropriate hazardous area classification.

1.19 COORDINATION, SHORT CIRCUIT AND OTHER STUDIES

A. General:

1. The Contractor shall engage the services of a professional electrical engineer, currently registered in the applicable state, to provide an Electrical Protective Device Coordination Study, an Electrical Short Circuit Study (for the power distribution and motor control equipment), and other Studies as defined herein. The Studies shall bear the engineer's seal,

license number and signature. The professional electrical engineer shall work with the approved switchgear manufacturer to provide these Studies for projects that have new switchgear. The Studies shall cover Coordination, Short Circuit, Harmonic Analyses and Arc-Flash as outlined herein.

2. Prior to major electrical equipment order placement, a preliminary short circuit calculation / study shall be prepared by Contractor and submitted for review. The study shall verify the adequacy of the Contract Documents-indicated or specified short circuit and related ratings for all new equipment as well as that of existing affected equipment, to the extent applicable. In the unlikely case that the study calculations indicate available short circuit or related values exceeding indicated or specified ratings for new equipment, or exceeding existing equipment ratings, Contractor shall inform Engineer, request clarification, and await instruction prior to further action. In no case, in accordance with NEC, shall equipment with ratings below calculated values be applied. After review and acceptance of the preliminary calculation / study, Contractor shall use it as a basis for preparation and submittal for review of a complete, thorough and detailed study, as specified herein.

3. The study shall also include the utility company's protective devices, all switchgear, all feeders, all switchboards, all MCCs and all panelboards. Every overcurrent and protective device shall be included in the study. The study shall include all electrical systems including those utility powered, on-site powered, generator powered, or other source powered. Include all "emergency systems", "legally required standby systems", "optional standby systems" and COPS systems as defined in NEC. All devices shall be evaluated for short circuit capabilities and shall be electrically coordinated as required by code and to the extent practical. Graphic indication of coordination shall be furnished in the form of a clearly labeled and identified composite drawing showing time-current curves of system protective devices. Time-current curves of each device shall also be furnished. Results and recommended settings shall be summarized in a clear and concise tabulation.

4. The Contractor shall be responsible for obtaining and verifying with the Electric Utility Provider all information needed to conduct this study. This includes, but is not limited to, actual service transformer KVA rating, impedence and available fault current.

5. The Contractor shall set all protective devices and relays based on this coordination study to provide coordinated, selective protection for all equipment supplied or affected by the installation under this Contract.

6. The Contractor shall provide data necessary to perform the study. This includes feeder cable sizes, approximate feeder length, motor data, switchgear data, existing protective relay settings and any other information relevant to the study.

7. A summary of the short circuit analysis shall be provided by the Contractor at the time shop drawings for all of the new equipment is submitted for approval.

8. Where applicable, for projects that expand existing facilities, the Contractor shall investigate the existing distribution system and prepare an up-to-date single line diagram for the existing system. The Contractor shall provide necessary information to clearly represent an existing single line diagram as required in order to perform the coordination and short-circuit study.

B. Scope:

1. The short circuit study shall be in accordance with ANSI Standard C37.010 and C37.13, shall be performed to check the adequacy, and to verify the correct application of circuit protective devices and other system components specified. Where applicable, the study shall address the case when the system is being powered from the normal source as well as from

the alternate source. Minimum as well as maximum possible fault conditions shall be adequately covered in the study.

2. Fault contribution of all motors shall be considered. The Contractor shall be responsible for obtaining all required data of equipment. All back-up calculations shall become part of the final report. The calculations shall be in sufficient detail to allow easy review.

C. Contents:

1. The study shall include representation of the power company's systems, the base quantities selected, impedance source data, calculation methods and tabulations, one-line and impedance diagrams, conclusions and recommendations. Short circuit momentary duties, shall be calculated on the basis of an assumed bolted three-phase short circuit at each medium voltage bus, low voltage switchboard bus, switchboards, motor control centers, distribution panelboards, pertinent branch circuit panelboards, and other significant locations through the systems. The short-circuit tabulations shall include significant X to R ratios, asymmetry factors, KVA, and symmetrical fault current.

2. A protective device time current coordination study shall be included with coordination plots of key and/or limiting protective devices, tabulated data, rating, and/or settings selected. The study shall present an engineering balance between the competing objectives of protection and continuity of service for the system specified, taking into account the basic factors of sensitivity, selectivity and speed. In addition to including all facility "normal" utility powered and / or generator powered electrical power systems, the coordination study shall include all protective devices utilized in emergency systems, legally required standby systems and elevator systems in order to confirm selective coordination to the extent required by the NEC.

3. Separate plots shall be provided for each mode of "normal" and "alternate" operation. Maximum fault values shall be shown in each case. Both power sources shown in one plot will not be accepted.

4. Where applicable, existing protective device settings shall be reviewed to ensure selectivity under the new conditions. Recommended changes shall be indicated in the report.

5. Required settings for breakers and relays shall be maximized to provide the most effective protection possible whether the system is fed from the normal or emergency source, where applicable.

6. Tabulations indicating recommended set points for all protective devices shall be provided. This shall include the normal as well as the alternate source.

D. Motor Current-Time Characteristic Curves:

1. A complete independent set of current-time characteristic curves for all medium voltage motor drives indicating coordination between the protective relays and the thermal characteristics of the motor shall be provided.

2. The Contractor shall obtain the necessary information to perform the study from the motor suppliers.

E. Motor Starting Study:

1. A motor starting study for all large electric drives (100 horsepower and above) to determine voltage dip or power inrush limitations at selected locations due to starting of motors shall be provided. This applies to both the normal and the alternate mode.

F. General Information for Time-Current Curves Presentations:

1. The coordination plots shall include complete titles, representative one-line diagrams, legends, associated power company's relay or system characteristics, significant motor starting characteristics, complete parameters for power, and substation transformers, and complete operating brands for low-voltage circuit breaker trip devices.
2. The coordination plots shall define the types of protective devices selected, together with the proposed coil taps, time-dial settings and pick-up settings required.
3. The short-time region shall indicate the medium voltage relay instantaneous elements, the magnetizing in-rush, and ANSI withstand transformer parameters, the low-voltage circuit breaker instantaneous trip devices, fuse manufacturing to tolerance bands, and significant symmetrical and asymmetrical fault currents.
4. Each primary protective device required for a delta-to-wye connected transformer shall be selected so that the characteristic or operating band is within the transformer parameters; which, where feasible, shall include a parameter equivalent to 58 percent of the ANSI withstand point to afford protection for secondary line-to-ground faults.
5. Low-voltage power circuit breakers shall be separated from each other and the associated primary protective device, where feasible, by a 16 percent current margin for coordination and protection in the event of secondary line-to-line faults.
6. Protective relays shall be separated, where feasible, by a 0.3 second time margin when the maximum three-phase fault flows, to assure proper selectivity.

G. Harmonic Analysis:

1. As part of the study, a harmonic analysis shall be performed. The study shall utilize approved computer software and shall follow industry approved procedures in concurrence with IEEE recommended methodology. The effects of variable speed drives and other non-linear system components on the power system including harmonic distortion to power, current and voltage shall be included.
2. Where such analysis indicates power system calculated harmonic content exceeding recommended interference limitations per IEEE 519-1992, or other industry recommendations, the study shall identify possible mitigating solutions including, but not limited to, additional filters, isolators, reactors, etc. The study shall identify the recommended type of mitigating device(s), ratings, recommended system point(s) of application and calculated harmonic improvement.

H. Arc-Flash Analysis:

1. A complete arc-flash analysis for the entire new and modified (as applicable) electrical system shall be prepared and submitted by Contractor. It shall be based on NFPA 70E and IEEE 1548. It shall be comprehensive and include all assumptions, data, calculations and recommendations. Such analysis shall determine arc-flash hazard at all operator access

points and provide recommendations for operator safety and precaution including protective clothing, danger / warning / hazard signs, safe work practices, clearances, floor markings of flash hazard boundaries, etc. All signs and floor markings shall be furnished and installed by Contractor in accordance with the study results and in accordance with Code. See NEC 110.16.

I. The coordination study shall be bound in a standard 8-1/2 inch X 11 inch size report and submitted in triplicate to the Engineer. The final selection of all protective devices shall be based on a preliminary draft of the coordination study that shall be submitted with the equipment shop drawings for review. The completed study shall be submitted to and approved by the Engineer before any of the equipment is shipped. All protective devices shall be adjusted, tested, and calibrated in the field, prior to energizing the equipment, per the settings listed in the study. This work shall be performed by the Manufacturer as described in this section and prior to final acceptance by the Owner.

J. Unless indicated otherwise, all new and existing protective devices shall be calibrated and tested by an approved independent testing firm. Testing shall be in accordance with industry standards and as recommended by the equipment manufacturer. This work shall be provided and accomplished under Section 16010.

1.20 WARRANTY

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Provide a warranty for all electrical equipment in accordance with the general requirements of specification. Unless specified more stringently elsewhere in the general requirements, the components of the electrical system shall be warranted for a period of one (1) year from the date of final acceptance, against defective materials, design and workmanship.

PART 2 - PRODUCTS

A. Materials of the same type shall be the product of one (1) manufacturer. In addition, major electrical items including switchgear, substations, switchboards, motor control centers, and power transformers shall be the product of one (1) manufacturer.

PART 3 - EXECUTION (SEE APPLICABLE DIVISION 16 SECTIONS)

END OF SECTION 16010

SECTION 16050
BASIC ELECTRICAL MATERIAL AND METHODS

PART 1 - GENERAL

1.01 SCOPE

A. This Section covers basic materials and methods not included in other Sections of Division 16.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 INDIVIDUAL MOTOR STARTERS

A. Manual Starters: NEMA ICS-2; general purpose type; trip-free mechanism; with overload relays. Provide pushbutton operation for integral horsepower sizes, and toggle switch for fractional sizes.

B. Magnetic Starters: NEMA ICS-2 Type A; NEMA size 1 minimum; magnetically held contactor with field replaceable coil and contacts; bimetallic or melting alloy overload relay, manually reset. Starters shall be rated and sized in accordance with NEMA size designations; fractional sizes and ratings per IEC recommendations are not acceptable.

C. Magnetic Starter Controls: All controls, unless otherwise noted or shown, shall be 120 volts. Equip each starter with a control power transformer fused on the primary and secondary. Provide starter and overload relay auxiliary contacts for red run light, green stop light and amber overload light on the enclosure door. Provide one (1) spare normally open starter auxiliary contact, and door mounted start-stop pushbuttons or hand-off-auto selector switch and other controls as indicated.

D. Combination Starters: Molded case circuit breaker rated 42,000 amps.

E. Acceptable Manufacturers: General Electric, Square D, Allen Bradley, Siemens, Cutler-Hammer or equal.

2.02 FUSES

A. Fuses: Current limiting, non-renewable type, rated 200,000 AIC, with rejection feature; Class RK-5 for motors and transformers for ratings 600 amp and below and Class L for feeders rated 601 amp and above.

B. Acceptable Manufacturers: Bussmann, Brush, Littelfuse or equal.

2.03 TERMINAL JUNCTION BOXES (TJB)

A. Provide hinged-cover terminal junction boxes of the required type and size where indicated. Utilize enclosures as required in 16000-2.01. Provide terminal blocks with a separate connection point for each conductor entering or leaving the box. Provide metal back plate for mounted

terminal blocks. Provide 20 percent spare terminal points. Paint interior surfaces with white enamel or lacquer.

2.04 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

A. For nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, provide heavy-duty, oiltight type pushbuttons, indicating lights, selector switches, and stations for these devices. Utilize General Electric Type CR 104P, or equivalent by Square D, Cutler-Hammer, or equal.

B. For nonhazardous, outdoor, or normally wet locations, or where otherwise indicated, provide heavy-duty corrosion resistant, watertight type pushbuttons, indicating lights, or selector switches mounted in NEMA 4X stainless steel (316) enclosures. Provide special gasketing required to make complete station watertight. Utilize Square D Type SK, General Electric, Cutler-Hammer, or equal.

C. Provide devices meeting the requirements of NEMA ICS 2, and having individual, extra large nameplates indicating their specific function. Provide pushbutton stations with laminated plastic nameplates indicating the drive they control. Provide contacts with NEMA designation rating A600.

D. Utilize selector switches having standard operating levers. Make all indicating lights push-to-test type. Provide ON or START pushbuttons colored black. Provide OFF or STOP pushbuttons colored red.

2.05 TERMINAL BLOCKS 0 TO 600 VOLTS

A. Provide 600-volt terminal blocks for termination of all control circuits entering or leaving equipment, panels, or boxes. Provide screw clamp compression, dead front barrier type terminal blocks with current bar providing direct contact with wire between the compression screw and yoke. Provide yoke, current bar, and clamping screws constructed of high strength and high conductivity metal. Utilize yoke that guides all strands of wire into the terminal. Utilize current bar providing dependable vibration-proof connection. Supply terminals constructed to allow connection of wire without any special preparation other than stripping. Rail mount individual terminals to create a complete assembly and provide terminals constructed such that jumpers can be installed with no loss of space on terminal or rail.

B. Size all terminal block components to allow insertion of all necessary wire sizes and types. Supply terminal blocks with marking system allowing the use of preprinted or field-marked tags. Supply CSA certified and UL approved terminal blocks manufactured by Weidmuller, Ideal, Electrovert, or equal.

2.06 CONTROL RELAYS

A. Provide magnetic control relays, NEMA Class A600 (600 volts, 10 amps continuous, 7,200VA make, 720VA break), industrial control type with field convertible contacts, and meeting the requirements of NEMA ICS 2. Provide General Electric Type CR120B, Cutler-Hammer Type M-600, or equal.

B. Where time delay relays are specified or required, unless otherwise noted, provide magnetic control relays with a timer attachment adjustable from 0.2 to 60 seconds (minimum) and field convertible from ON delay to OFF delay and vice-versa.

C. Where latching (mechanically held) relays or motor thermal detector relays are specified, provide magnetic control relays with mechanical latch attachment with unlatching coil and coil clearing contacts. Utilize an attachment allowing 01 easy manual latching and unlatching.

2.07 ELAPSED TIME METERS

A. Provide synchronous-motor-driven, elapsed time meters, to 99,999.9 hours range, nonreset type, suitable for semiflush, panel mounting. Provide General Electric Type 240, 2-½-inch Big Look unit, Eagle Signal Bulletin 705 unit, or equal.

2.08 CIRCUIT BREAKERS, INDIVIDUAL, 0 TO 600 VOLTS

A. Mount individual circuit breakers complying with requirements for circuit breakers in this section in enclosure required for the location, unless otherwise indicated. Provide circuit breakers with handles that can be locked in the OFF position. Interlock enclosure and circuit breaker to prevent opening the cover with the circuit breaker in the ON position.

2.09 CIRCUIT BREAKERS, 0 TO 600 VOLTS

A. General: Provide circuit breakers of the indicating type showing ON/OFF and TRIPPED positions of the operating handle. Do not use single-pole circuit breakers with handle ties where multipole circuit breakers are indicated. Utilize multipole circuit breakers designed so that an overload on one pole automatically causes all poles to open. Provide circuit breakers meeting the requirements of NEMA AB 1. Circuit breakers shall have a minimum interrupting rating equal to the maximum fault current available at the point of application or they shall be part of an assembly with an integrated equipment short circuit rating at least as great as the fault current available at the point of application. Where circuit breakers are used as service entrance equipment, provide units UL labeled for that use. Provide circuit breakers suitable for use with 75 degrees C wire at full NEC 75 degrees C ampacity.

B. Inverse Time Type:

1. Provide thermal-magnetic circuit breaker, unless otherwise shown, for one- and two-pole breakers, breakers operating- at 240V or less, and three-pole branch circuit breakers operating at 480V.

2. Provide solid state trip circuit breakers with an adjustable short-time function, unless another type breaker is required for coordination, or otherwise indicated on the Drawings, for three-pole, 480V feeder circuit breakers with not more than one downstream, 480V, overcurrent protective device, excluding protective devices provided as part of a process equipment package. Such breakers shall be Cutler-Hammer Seltronic Circuit Breakers, Square D, Type ME or PE Circuit Breakers, or equal.

3. Provide solid-state trip circuit breakers with at least the following adjustment: long time pickup, long time delay, short time pickup, short time delay, I-squared t, for circuit breakers not covered by either of the above cases. Such breakers shall be General Electrical Circuit Breakers with Microversatrip; Cutler-Hammer Circuit Breakers with Digitrip; or equal.

C. Instantaneous Only Type: Instantaneous only circuit breakers shall have only an instantaneous trip element. The breakers shall be used only as part of a listed combination motor starter. Instantaneous only breakers shall be sized with a continuous rating of at least 115 percent of the full-load current of the motor served. The trip setting shall be continuously adjustable from a lowest setting of not more than 700 percent to a highest setting of not less than 1,300 percent of the motor full-load current. Instantaneous only breakers shall be General Electric Mag-Break; Westinghouse MCP; Square D Mag-Guard; or equal.

2.10 SUPPORTING DEVICES

A. Support Channel: Fiberglass, according to 16000-2.01

B. Hardware: Stainless steel, according to 16000-2.01.

2.11 ELECTRICAL IDENTIFICATION

A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.

B. Wire and Cable Markers: Plastic, split sleeve or tubing type.

2.12 PLYWOOD BACKBOARDS

A. Backboards: Grade BC plywood, ¾-inch thick. Paint with two coats of flat black paint.

PART 3 - EXECUTION

3.01 INDIVIDUAL MOTOR STARTERS

A. Select and install heater elements in motor starters to match installed motor characteristics. Do not use NEC motor full load ampere data for heater selection.

B. Provide a typed label inside each motor starter enclosure door identifying the motor served and listing the motor nameplate data. Provide an engraved nameplate on the exterior of the enclosure door identifying the motor served, the horsepower, voltage, and phase rating.

C. Enclosure type, unless otherwise indicated, enclosures shall be according to Section 16000-2.01.

D. Install starters so they are rigidly supported and readily accessible. Where mounted on stud walls, provide a non-flammable backboard secured to the studs with the starter secured to the backboard. Provide stainless steel mounting channel or phenolic spacers to give nominal ½ inch separation from concrete walls in wet or damp locations.

3.02 FUSES

A. Equip all fusible devices with fuses. Replace all blown fuses up to final acceptance of the Project. At the completion of the Project, turn over to the City spare fuses for each type and size installed; six each for ratings 60 amps and below, and three each for ratings above 60 amps.

3.03 TERMINAL JUNCTION BOXES (TJB)

A. Install in accordance with all the requirements detailed under Section 16130, Boxes. Label each block and terminal with a permanently attached, nondestructible tag.

3.04 SUPPORTING DEVICES

A. Fasten hanger rods, support stands, conduit clamps, etc. to building structure using approved material.

B. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit. Do not use powder actuated fastening devices. Do not drill structural steel members.

3.05 ELECTRICAL IDENTIFICATION

A. Provide nameplates for all switchboards, panelboards, transformers, disconnect switches, individual motor starters, and other items of electrical distribution equipment. Engrave with the equipment identification as indicated, and the voltage rating. Attach nameplates with screws or rivets; adhesives are not acceptable.

END OF SECTION 16050

SECTION 16111
CONDUIT RACEWAY SYSTEMS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of raceways, including metallic conduit and fittings, non-metallic conduit and fittings, flexible metal conduit (Greenfield) and fittings, liquid tight flexible non-metallic conduit and fittings, explosion proof flexible conduit, cable tray, wire trough, manholes, handholes and ductbanks. All raceways shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Minimum conduit size shall be 3/4" for all wiring unless shown otherwise on the Contract Drawings. All conduit sizes if not specifically shown on the Drawings shall be in accordance with Chapter 9, NEC. All boxes and fittings shall be of the same material or have the same surface treatment or coating as the conduit serving same.

D. All wiring shall be enclosed in raceways unless otherwise indicated. All raceways shall be as indicated on the Contract Drawings and as noted below:

1. Rigid galvanized steel conduit.
2. Electrical metallic tubing conduit.
3. Polyvinyl chloride (PVC) conduit.
4. Polyvinyl chloride coated metallic conduit.
5. Flexible metal conduit (Greenfield) may be used in final connections from ceiling outlet box to light fixtures above hung ceilings or in joist spaces, or for other work in existing buildings, as approved by the Engineer. Maximum length 6'-0" unless otherwise approved by Engineer.
6. Liquid tight flexible conduit shall be used for final connections to motors, vibrating or moving equipment in non-explosion-proof areas. Make connection with a 360o loop with a minimum radius of 10 times the conduit size.
7. Auxiliary gutters and wireways shall be used for grouped circuits adjacent to grouped panels or switchgear, and at the Contractor's option for other grouped circuits as approved by the Engineer.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Equipment data specified in this Section.
2. Catalog cuts.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI C80.1.
2. ASTM F 512.
3. Fed Spec WW-C-581E.
4. Fed Spec WW-C-1094A.
5. NEMA TC2.
6. NEMA TC6.
7. NFPA 70.
8. UL 1.
9. UL 6.
10. UL 360.
11. UL 651.

1.04 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with NEMA standards, and shall be UL approved.

B. Manufacturers offering products that comply with these specifications include:

1. Conduit: Allied, Republic, Triangle, Wheatland, or equal.
2. PVC Coated Conduit: Permacote, Robroy, or equal.
3. PVC Conduit: Amoco, Carlon, Certainteed, or equal.
4. Flexible Conduit: Anamet, Columbia, Electrilex, or equal.
5. Fittings: Appleton, Crouse-Hinds, Thomas & Betts, or equal.

PART 2 - PRODUCTS

2.01 GENERAL

A. The type and size of raceway shall be as specified on the Drawings or schedules. Lighting, receptacle and other raceways are not scheduled and shall be sized by the Contractor in accordance with the NEC. Minimum size shall be ¾-inch for exposed and 1-inch for embedded raceway. The number and size of communication and security raceways shall be as required for the particular equipment provided, subject to the minimum sizes specified above.

2.02 METALLIC CONDUIT AND FITTINGS

A. Rigid Steel Conduit: UL 6; ANSI C80.1; Federal Specification WCC-581; hot dip galvanized. Minimum size 3/4-inch, exposed, 1-inch embedded or inaccessible.

B. PVC Coated Conduit: NEMA RN-1; galvanized rigid steel conduit with factory applied external 40 mil PVC coating and 2 mil urethane interior coating. Prior to coating, treat conduit with a heat polymerizing adhesive so the bond between metal and coating is greater than the tensile strength of the coating. All fittings, boxes and conduit accessories shall be coated and of the same manufacture to assure an extremely corrosion resistant raceway system. Minimum size ¾-inch.

C. Electrical metallic tubing conduit shall be UL labeled and shall conform with UL 1243 and Federal Specification WWC-581, hot dipped galvanized.

D. Metallic auxiliary gutters or wireways shall be formed heavy gage sheet steel, hinged and screw attached steel covers, bonderized with baked enamel finish.

E. Rigid Aluminum Conduit: UL6; ANSI C80.5; Alloy 6063; Temper T-1. Minimum size ¾-inch.

F. Fittings and Conduit Bodies: NEMA FB-I; zinc coated; taper-threaded type, material to match threaded metallic conduit. Where PVC coated conduits are indicated all couplings, fittings, conduit bodies, pipe straps, U bolts, beam clamps, and other accessories are to be PVC coated.

2.03 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Conduit: UL 1; FS WW-C-566; single steel continuous strip with galvanized coating. Minimum size ½-inch.

B. Fittings and Conduit Bodies: NEMA FB-1; malleable iron squeeze type.

2.04 LIQUIDTIGHT FLEXIBLE CONDUIT AND FITTINGS

A. Conduit: UL listed liquid tight, non-metallic, sunlight and corrosion resistant, extruded thermoplastic. Minimum size ¾-inch. Metallic liquid tight flexible conduit is not acceptable.

B. Fittings and Conduit Bodies: NEMA FB-1; non-metallic compression type with O-ring.

2.05 RIGID NONMETALLIC CONDUIT AND FITTINGS

A. Conduit: Rigid polyvinyl chloride (PVC), UL listed for concrete-encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90 degrees C insulation. Use conduits, couplings, bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W-C-1094, UL-651, NEC, and ASTM specified tests for the intended use. Use only conduit with a factory formed bell on one end. Conduit that requires the use of couplings for straight runs will not be acceptable. Use Schedule 40 for concrete encased conduit. Use Schedule 80 elsewhere. Minimum size ¾-inch exposed, 1-inch embedded or encased.

B. Fittings for PVC conduit shall comply with Standard for PVC Fittings for use with Rigid Conduit and Tubing, NEMA TC3, and shall be NEMA Type IV.

C. PVC auxiliary gutters or wireways shall be high-impact resistant, nonmetallic, corrosion resistant PVC with clip-on covers.

2.06 EXPLOSION PROOF FLEXIBLE STEEL CONDUIT

A. Conduit shall be suitable for use in Class 1, Division 1, Groups C and D hazardous areas as specified in NEC and shall be watertight. Flexible conduit shall be used for final connections to motors and other equipment subject to vibration or adjustment in Class 1, Division 1 hazardous areas. Minimum size ½-inch.

2.07 PRECAST HANDHOLES AND MANHOLES

A. Install handholes and manholes with 28-day, 2,500 psi minimum compressive strength concrete and designed for AASHTO H-20 loading. Minimum dimensions for handholes and manholes are shown on the Drawings. Increase these as required by use of extension sections to accommodate the several raceway entrances at their required elevations.

B. Slope floors toward drain points, leaving no pockets or other nondraining areas. Provide a drainage outlet at the low point of the floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and 4-inch minimum outlet and outlet pipe.

C. Provide raceway entrances on all four sides. For raceways installed under this Contract, knockout panels or precast individual raceway openings may be used. On sides where no raceways are installed under this Contract, provide 12-inch high by 24-inch wide (minimum) knockout panels for future raceway installation.

D. For manholes, utilize heavy-duty type frames and covers made of stainless steel, suitable for H-20 loading, and having machined bearing surfaces. Provide indented type covers, solid top design, with two drop handles each. On the upper side of each cover, cast or burn by welder, in integral letters not less than 2 inches high appropriate titles, ELECTRIC-HV (for above 600 volts), ELECTRIC-LV (for 600 volts and below), or COMMUNICATION. Field stamp covers with handhold and manhole numbers indicated on the Drawings.

E. For handholes, frames and covers shall conform to ASTM A48-83 and shall be slab type with letters as indicated above.

F. Provide heavy weight cable racks with adjustable arms and acceptable insulators for all cables in each handhold and manhole. Set adjustable inserts in the concrete walls for the attachment of racks. Do not use bolts or studs embedded in concrete for attaching racks. Set racks and inserts on not greater than 3-foot centers around the entire inside perimeter of the manhole, arranged so that all spare conduit ends are clear for future cable installation. Provide stainless steel racks with a sufficient number of arms and insulators to accommodate cables for each conduit entering or leaving the handhold, including spares.

G. Provide pulling irons. Utilize ¾-inch round stock securely fastened to the overall steel reinforcement before concrete is poured.

H. Utilize handhole and manhole hardware of stainless steel construction only after fabrication.

I. Manufacturers: Brooks Products, Inc.; Penn-Cast Products, Inc.; Concrete Conduit Company; Associated Concrete Products, Inc, or equal.

2.08 WARNING TAPE

A. Provide heavy-gauge, yellow plastic tape of 6-inch minimum width for use in trenches containing electric circuits. Utilize tape made of material resistant to corrosive soil. Use tape with printed warning that an electric circuit is located below the tape. Manufacturers and types: Equal to: ITT Blackburn Type YT or RT; Griffolyn Co. Terra-Tape.

2.09 RACEWAY IDENTIFICATION

A. Raceways number tags shall be brass with stainless steel attachment wire. Raceway number shall be embossed on to the tag with ¼-inch letters.

PART 3 - EXECUTION

3.01 CONDUIT SCHEDULE

A. Use RGS or EMT steel conduits for indoor clean area or as indicated on the Drawings.

B. Use liquid tight flexible non-metallic conduit for connections to motors, transformers, and other vibrating equipment.

C. Non-jacketed flexible steel conduit may be used for connections to large transformers and motors or lighting fixtures in suspended ceilings.

D. Use PVC coated conduits where conduits are in direct contact with earth or where conduits are installed in corrosive areas.

E. Use PVC conduits where conduits are embedded in concrete structures, encased in concrete duct bank or concealed in concrete block CMU.

F. Where PVC conduit is indicated, make a transition to PVC coated rigid steel below grade or slab and continue above with PVC coated rigid steel conduit.

G. Exception: PVC may enter switchboards, motor control centers or other floor standing electrical equipment enclosures.

3.02 CONDUIT ARRANGEMENT AND SUPPORT

A. Arrange conduit to maintain headroom and present a neat appearance. Run exposed conduits parallel or perpendicular to building surfaces and adjacent piping. Group conduit in parallel runs where practical and provide rack space for 25 percent additional conduits.

B. Avoid sources of heat when possible. Where unavoidable, maintain 6-inch clearance when crossing hot pipes and 12-inch clearance between parallel hot pipes, flues, heating appliances, and other heat sources.

C. Support conduits to prevent distortion of alignment by wire pulling operations. Fasten single conduits with one hole malleable iron straps. For multiple runs use galvanized steel channel and clamps. Wire, perforated pipe straps and the like are not acceptable support means.

D. Support conduit at a maximum of 7 feet on center and within 3 feet of each box, cabinet, or fitting. Hang trapeze assemblies with threaded rods not less than 3/8-inch diameter. Remove all temporary supports prior to pulling conductors.

3.03 CONDUIT INSTALLATION

A. Raceways shall be installed between equipment essentially as shown. Raceway systems shall be electrically and mechanically complete before conductors are installed. Bends and offsets shall be smooth and symmetrical, and shall be accomplished with tools designed for this purpose. Factory elbows shall be utilized wherever possible.

B. Where raceway routings are designated on plan views, the Contractor shall follow those routings to the extent possible.

C. Where raceways are designated, but not shown, such as home runs or on conduit block diagrams and schedules, raceway routings shall be at the Contractor's discretion, in strict accordance with the N.E.C., customary installation practice, and/or as designated, i.e., encased, exposed, under floor, etc.

D. Routings shall be adjusted to avoid obstructions. Coordinate with all other trades prior to installation of raceways. Lack of such coordination shall not be an excuse for extra compensation, and removal and reinstallation shall be at no extra cost to the OWNER.

E. Cut conduit square using a saw or pipe cutter and de-burr and ream cut ends. Paint all threads with zinc compound. Bring conduit to the shoulder of fittings and couplings and fasten securely. All connections are to be wrench tightened and electrically continuous. No running threads are permitted.

F. Use conduit hubs for fastening conduit to boxes. Use conduit bodies to make sharp changes in direction. For sizes 2-inches and larger, use "LD", Mogul, or similar fittings to permit a straight pull from either direction.

G. The maximum length between pull points is 400 feet. This length shall be reduced by 100 foot for each 90 degree of bend.

H. Use hydraulic one-shot shoe bender or factory elbows for bends in conduit larger than 2-inch size. Crushed or deformed conduits may not be installed.

I. Avoid moisture traps where possible; where unavoidable, provide junction box with drain fitting at conduit low point.

J. Use suitable conduit caps to protect installed conduit against entrance of dirt and moisture. Install threaded PVC end caps on conduits stubbed up for future use.

K. Unless otherwise specified, conduit entering field equipment enclosures shall enter the bottom or side of the box.

L. Provide a 200 pound tensile strength polyolefin line pulled through and tied off at each end of all empty conduits.

M. Install expansion joints where conduit crosses building expansions joints and for straight runs in excess of 100 feet.

N. Where conduit penetrates fire-rated walls and floors, provide mechanical fire-stop fittings with UL listed fire rating equal to wall or floor rating.

O. Provide watertight conduit seals, equal to OZ type WSK or FSK, where conduit penetrates exterior walls below grade.

P. Provide watertight cable seals, equal to OZ type CRC or CRN for conduit that penetrates exterior walls below grade or for conduit that passes between spaces normally at different temperatures.

Q. All exposed raceways shall be installed at least one-half (1/2) inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, exposed raceways shall be installed one-quarter (1/4) inch minimum distant from the face of walls or ceilings by the use of clamp backs and/or struts.

R. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, suitable insulating means shall be provided to prevent such corrosion.

S. Route conduits in slabs above the bottom reinforcing and below the top reinforcing. Maximum size for conduits in slabs above grade is 1-inch. Route so conduits in slabs above grade do not cross.

T. PVC conduit bends: Use PVC-coated rigid steel factory elbows.

U. PVC coated conduit: Exercise care not to damage the coating during cutting, threading, bending, and assembly. Follow the manufacturer's installation instructions. Use vise jaws, bending equipment, strap wrenches, and other tools, which are specifically designed for coated conduits. Do not use chain vise, pipe wrench, channel locks or the like.

V. Provide sealing compound equal to Chico A or Chico B where conduit passes from hazardous or corrosive area in to a non-classified area.

W. Each conduit shall be provided with a number tag at each termination.

X. Contractor will provide chases, recesses, and wall pockets in new construction as specified or shown on Contract Drawings. Check architectural and structural design and shop drawings to

verify correct size and location for all openings in general construction work. Supply information in ample time, giving size and exact locations, furnishing templates if required.

Y. Provide all required sleeves and inserts of material and type specified. Set sleeves and inserts in place ahead of new construction, securely fastened during pouring. Correct, by drilling, all omitted or improperly located sleeves. Plug all abandoned sleeves as directed.

Z. Provide pipe sleeves for all conduit passing through masonry walls above grade or concrete floors. Sleeves shall be 1/2" larger than conduit and adequately calked watertight and finished with escutcheon plates. Floor sleeves shall extend 3 inches above the floor elevation and shall be encased in a minimum of 2 inches of concrete around each sleeve.

AA. Provide roof flashings for all conduits passing through roofs compatible with the type of roof construction. All installations shall be watertight.

BB. After installing conductors, seal inside of conduits where passing through walls containing vapor seals or where reduction of sound transmission is required. Sealing may be accomplished by locating junction box or approved fitting at wall and filling with an approved compound.

3.04 UNDERGROUND DUCT BANK INSTALLATION

A. Install top of duct bank minimum 24-inches below finished grade with plastic warning tape 12-inches below finished grade.

B. Install conduit with minimum grade of 4-inches per 100 feet.

C. Terminate conduit in end bell at manhole entries.

D. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank. Use suitable separators and chairs installed not greater than 4 feet on centers to provide conduit spacing as indicated. Securely anchor conduit to prevent movement during concrete placement. Stagger conduit joints in concrete encasement 6-inches minimum.

E. All underground electrical duct bank encasements shall be reinforced. Reinforcing shall consist of steel rods to prevent shearing and/or cracking of the concrete envelopes. Provide #4 rebars at corners on top and bottom. Longitudinally, provide #4 rebars at 8-inch centers; 4 bars minimum. Transversely, provide #4 u-shaped rebars at 12-inch centers with vertical legs lapping a minimum of 6-inches. Provide 3-inch, minimum concrete cover all around the reinforcing rods. Concrete shall be F'c = 3 KSI, Fy = 60 KSI with Schofield Red Dye throughout the encasement applied at 10 lbs per cubic yard to the concrete mix.

F. Where duct bank passes beneath footings or slabs resting on grade excavate to provide a minimum of 6-inch clearance between the ductbank and the structure.

G. Utilize only long radius (minimum 36 inch) elbows and bends where conduit duct bank changes direction or conduit stubs up.

H. Thoroughly swab inside of conduits upon completion of pouring concrete. Before backfilling, a mandrel, ½-inch smaller than the conduit diameter, shall be pulled through each conduit.

3.05 HANDHOLES AND MANHOLES

A. Install handholes and manholes where shown on the Drawings. Provide excavation, shoring, bracing, backfilling, grading, etc., in accordance with requirements specified in Division 2 of these Contract Documents.

B. Do not install handholes or manholes until final conduit grading, including field changes necessitated by underground interferences, has been determined. Set frames to final grades as required.

C. Install one ground rod in each handhold and/or manhole. Connect all non-current carrying metal parts in the manhole or hand hole and any metallic raceway grounding bushings to this ground rod with No. 6 AWG (minimum) copper conductor.

END OF SECTION 16111

SECTION 16119
UNDERGROUND DUCTS AND UTILITY STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes:

1. Underground conduits.
2. Ducts, and duct banks.
3. Pull boxes.
4. Handholes, and manholes.
5. Other underground utility structures.

B. Products furnished and installed under this Section include pulling eyes, cable stanchions, cable arms, and insulators.

1.03 REFERENCED DOCUMENTS

A. Industry Standards:

1. American National Standards Institute, Inc. (ANSI):
   a. C2 National Electrical Safety Code
   b. C80.1 Rigid Steel Conduit
2. National Electrical Manufacturers Association, Inc. (NEMA):
   a. TC-2 Rigid Nonmetallic Conduit
   b. TC-3 PVC Conduit and Tubing Fittings
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC)

B. Government Standards:

1. U.S. Department of Labor, Occupational Safety and Health Administration (OSHA): Code of Federal Regulations, Title 29, Chapter XVII:
   a. Part 1910, Subpart S, Electrical, Revised by CFR 4056, January 16, 1981.
   b. Part 1926, Subpart K, Electrical, Revised by 51 CFR 25318, July 11, 1986

1.04 SUBMITTALS

A. General: Submit the following according to the General Conditions of the Contract and Division 1 Specification Sections.

B. Product data for metal accessories for manholes and handholes, conduit and duct, duct bank materials, and miscellaneous components.

C. Field test reports indication and interpreting test results relative to compliance with performance requirements of "Field Quality Control" Article in Part 3 of this Section.

D. Record Documents: Show dimensioned locations of underground ducts.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70 and ANSI C2 for components and installation.

B. Listing and Labeling: Provide products that are listed and labeled for their applications and installation conditions and for the environments in which installed.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code", Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

C. Coordinate layout and installation of ducts, manholes and handholes with final arrangement of other utilities as determined in the field.

D. Coordinate elevations of duct and duct bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and ensure duct runs drain to manholes and handholes and as approved by the Architect.

1.06 DEFINITIONS

A. Duct: PVC conduit used underground, embedded in concrete (concrete with rebar reinforcement).

B. Duct Bank: 2 or more PVC conduits installed underground in the same concrete envelope (concrete with rebar reinforcement).

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

1.08 EXTRA MATERIALS

A. Furnish extra materials matching products installed, packaged with protective covering for storage and with identification labels clearly describing contents.

B. Furnish cable stanchions, support arms, insulators, and associated fasteners each in quantities equal to 5 percent of quantities installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the Work include, but are not limited to, the following:

1. Nonmetallic Ducts:
   a. CANTEX, Inc.
   b. Carlon; Lamson & Sessions Company.
   c. Pipe & Plastic Group; Certainteed Products Corp.

2.02 CONDUIT AND DUCT

A. Rigid Steel Conduit: ANSI C80.1, galvanized.

B. Rigid Plastic Conduit: NEMA TC 2, Schedule 40 PVC, rated for use with 90 deg C conductors under all installation conditions. Suitable for above ground, direct burial, concrete encased and direct sunlight applications. ASTM class DB (suitable for direct burial without concrete encasement). Where subject to damage, use Schedule 80 PVC.

C. PVC Conduit and Tubing Fittings: NEMA TC3.

2.03 ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacing and concrete cover depths indicated, while supporting ducts during covering.

B. Duct Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, workable at temperatures as low as 35 degree F (1 degree C), withstands temperature of 300 degree F (149 degree C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheathes, cable jackets, insulation materials, and the common metals.

2.04 CONSTRUCTION MATERIALS

A. Concrete: Where applicable, conform to Division 3 Section "Cast-In-Place Concrete" for concrete and reinforcing.

1. Strength: 3,000 psi (20.7 Mpa) minimum 28 day compressive strength.
2. Aggregate for Duct Encasement: 3/8 inch (10mm) maximum size.

B. Concrete: Where applicable, conform to Division 3 Section "Pre-Cast Concrete".

C. Concrete Reinforcement: All underground structures, including duct banks, shall utilize concrete reinforced with rebar. Intent is for rebar details to be in accordance with Division 3 requirements and / or Division 16 details as shown on the Drawings. In the absence of Division 3 or Division 16 Drawing details, structure and duct bank rebar shall be #4 steel rebar. Install rebars in a continuous horizontal manner, arranged in parallel for the entire duct bank length, along all the structure's or duct bank's top and bottom corners. Provide additional intermediate #4 rebars

parallel to these and arranged such that 18 inches maximum spacing between horizontal rebars is maintained for the entire duct bank length. Also, duct banks shall have #4 rebar ties every 18 inches on center for the entire length of the duct bank; these placed across and perpendicular to the bank horizontal axis and encompassing the top, sides and bottom of the bank. Overlap the ends of the rebar ties.

2.05 MANHOLES AND HANDHOLES

A. Cable racks, supports, pulling-in-irons, manhole steps and hardware shall be hot dipped galvanized steel as manufactured by Line Materials Co. or equal.

B. Precast concrete manholes and handholes shall be heavy duty type, designed for a Class H20 wheel load. Precast manholes and handholes shall be as manufactured by Brooks Products Co.

C. Manhole frames and covers shall be cast iron heavy duty type for class H-20 wheel loading, and shall be as manufactured by Neenah, or equal. Manhole covers shall be marked Electrical Medium Voltage or Electric Low Voltage as applicable, in addition stamp the manhole covers with minimum 1-1/2 inch high letters and numbers for manhole identification. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2 inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

D. Handhole covers and frames shall be hot dipped galvanized and designed for a Class H-20 wheel load. Handhole covers and hatches shall have 316 stainless steel security bolts. Handhole covers shall be marked Electric Medium Voltage or Electric Low Voltage as applicable, in addition stamp the handhole covers with minimum 1-1/2 inch high letters and numbers for handhole identification. Provide gasketed covers with stainless steel non-standard bolt head configuration security bolts. Provide two (2) special 1/2 inch drive sockets to fit the security bolts supplied. Apply anti-siege compound to the security bolts prior to installation.

E. Manholes and Handholes shall be installed with features to permit passive drainage as detailed on the Drawings. In the absence of such detail, provide 3" PVC sleeve at low point of structure extending to a depth approximately 12" below the bottom surface of the structure. Provide a finely crushed and packed stone base below the structure to a total depth of approximately 24" to permit structure drainage. Provide drain cover.

F. Bell ends and plastic duct spacers shall be as manufactured by Carlon or equal.

PART 3 - EXECUTION

3.01 APPLICATION

A. Underground Ducts for Electrical Utility Service: Plastic conduit encased in concrete.

B. Underground Ducts for Electrical Feeders: Plastic conduit encased in concrete.

C. Underground Ducts for Telephone Utility Service: Plastic conduit encased in concrete.

D. Underground Ducts for Communication Circuits: Plastic conduit encased in concrete.

3.02 EXAMINATION

A. Examine site to receive ducts and manholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.03 EARTHWORK

A. Excavation and Backfill: Conform to Division 2 Section "Earthwork", but do not use heavy-duty, hydraulic-operated compaction equipment.

B. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing or dirt, cable lay, and other work. Restore vegetation and include necessary topsoil, fertilizing, liming, seeding, sod, sprigging, or mulching.

C. Restore disturbed paving. Refer to "Cutting and Patching" in Division 1.

3.04 CONDUIT AND DUCT INSTALLATION

A. Install Non-metallic conduit and duct as indicated according to manufacturer's written instructions.

B. Slope: Pitch ducts minimum of 4 inches per 100 feet (1:300) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m) both horizontally and vertically at other location.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Building Entrances: Transition from underground duct to conduit 10 feet (3 m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below:

1. Concrete-Encased Ducts: Install reinforcing in duct banks. Coordinate duct bank with structural design to support duct bank at wall without reducing structural or watertight integrity of building wall.
2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing to the device to make permanently watertight.

F. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and require duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.

Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in 1 continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4 inch (18mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete on both sides of joint near the corners of the envelope.

3. Reinforcing: Reinforce duct banks as specified.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions, otherwise, use

5. Minimum Clearances Between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100mm) between power and signal ducts.

6. Depth: Except as otherwise indicated, install top of duct bank at least 24 inches (600 mm) below finished grade in general areas and at least 30 inches (750 mm) below finished grade in vehicular traffic areas.

7. Install identification marker tape in accordance with section 16195.

G. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5 m) from edge of pad. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete.

H. Sealing: Provide temporary closure at terminations of ducts that are wired under this Project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (103 Kpa) hydrostatic pressure.

I. Pulling Cord: Install 100 pound test nylon cord in ducts, including spares.

3.05 MANHOLE AND HANDHOLE INSTALLATION

A. Raceway terminations at manholes shall be with end bells for PVC conduit and insulated throat grounding bushings with lay-in type lugs for metal conduit.

B. Install pulling-in irons opposite all raceway entrances to manholes and in the center of the manhole floor. Pulling irons shall be cast into the walls and floor. Bolt on style pulling irons are not acceptable.

C. Cables shall be completely looped within manholes and handholes. Cables shall be trained in manholes and supported on racks and hooks at intervals not greater than 3 feet-0 inches and supports shall be installed on each side of all splices. Furnish cast in place inserts on all manhole walls for mounting future racks as well as racks required for present installation. Branch circuit conductors shall not be run in manholes. Bolt and anchor surface installation is not acceptable.

D. All joints shall be made so as to prevent the passage of concrete inside the conduit to form obstructions or cause cable abrasions.

E. Manhole covers in streets shall finish flush with finished paving and in other areas shall finish 3 inches above crown of adjacent roadway. Floor elevations of manholes shall be so set that the center line of the lowest conduit entering will be not less than 1 foot above the floor and center line of the highest conduit entering will be not less than 1 foot below the roof slab.

F. A 3/4 inch by 10 foot copper clad ground rod shall be driven in the bottom of each manhole. All bond wires, galvanized conduits and metal cable racks shall be bonded to the ground rod.

G. Polyethylene warning tape shall be provided for all underground raceways, duct banks, etc. Tape shall be placed along the raceways entire length and shall be installed 18" above the raceways on compacted backfill material, unless noted otherwise.

H. Raceways installed in the multiple run duct banks shall be installed so that the coupling if adjacent raceways are not in one shear plane.

I. Install a bare copper cable in the concrete encased duct bank. Size shall be as shown on the Drawings. In the absence of cable size being shown on the Drawings, it shall be #1/0. It shall be continuous from one end to the other for the entire length of the ductwork and shall be bonded to building steel on each end and to all manhole-handhole ground loops and associated manhole-handhole ground rods.

J. Install expansion deflection fittings as required by the NEC and duct bank raceway manufacturer.

3.06 FIELD QUALITY CONTROL

A. Testing: Demonstrate capability and compliance with requirements upon completion of installation of underground duct and utility structures.

1. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
2. Duct Integrity: Rod ducts with a mandrel ¼ inch (6 mm) smaller in diameter than internal diameter of ducts. Where rod indicates obstructions in ducts, remove the obstructions and retest.

B. Correct installations where possible, and retest to demonstrate compliance. Otherwise, remove and replace defective products and retest.

3.07 CLEANING

A. Pull brush through full length of ducts. Use round bristle brush with a diameter 1/2 inch (12.5 mm) greater than internal diameter or duct.

B. Clean internal surfaces of manholes including sump. Remove foreign material.

END OF SECTION 16119

SECTION 16120
WIRE AND CABLE

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of building wire, cable and wiring connections and terminations. All wire and cable shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Minimum size for all power and lighting wiring shall be #12 AWG. Minimum size for control and alarm wiring shall be #14 AWG.

C. All wire shall be soft drawn copper conforming to ASTM Standard B-3. All wire shall be single conductor type unless otherwise indicated. All wire shall be stranded in accordance with ASTM Standard B-8.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data.
2. Maximum pulling tension and recommended lubricant for 15kv cables, provide calculations. Pulling tension during installation shall be measured and documented.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Power/Control Conductors: Equal to: Cablec; Collier; Okonite; Pirelli; Southwire; Triangle.

B. Instrumentation Conductors: Equal to: Belden; Dekoron; Penn.

C. Low Voltage Connectors: Equal to: Burndy; Thomas & Betts; Ideal; OZ.

D. Pulling Compounds: Equal to: Ideal Yellow 77; Electro Y-ER-EAS; Minerallac 100; Burndy Slikon.

E. Or equal.

2.02 SINGLE CONDUCTOR 600 VOLT CABLE

A. Power distribution feeder and power/control circuit conductors in sizes 250 KCM and larger or any conductors installed in underground conduit shall be insulated with ethylene propylene rubber and jacketed with Hypalon. The cable shall be rated for 600 volts and 90 degree centigrade conductor temperature in dry or wet locations.

B. Power, lighting, receptacle and other branch circuit conductors in sizes smaller than 250 KCM and installed in dry, interior locations and insulated equipment grounding conductors shall be moisture and heat resistant, thermosetting, crosslink polyethylene type XHHW-2. The cable shall be rated for 600 volts and 90 degree centigrade conductor temperature in dry or wet locations.

2.03 MULTICONDUCTOR TRAY CABLE

A. Multiconductor tray cable shall be stranded coated or uncoated copper conductors with color-coded flame retardant, crosslinked polyethylene insulation. Three (3) or more conductors shall be twisted with suitable nonhydroscopic fillers where necessary to make a round cable. Each cable shall have a heavy duty Hypalon protective jacket applied over the assembly. The cables shall be rated for 90°C conductor temperature in wet or dry locations. Cables shall meet the requirements of ICEA Pub. No. S-66-524, NEMA Pub. No. WC7, ICEA S-19-81 Para. 6.19.6 UL VW-1 and shall be suitable for cable tray installation.

B. Multiconductor tray cable shall be equal to type FR-XLP as manufactured by Rome Cable Corporation.

2.04 INSTRUMENTATION CABLE

A. Electronic transmission shall be via stranded, shielded, twisted conductors of not less than 18 AWG conductor wire. All termination points shall have terminal lugs. Instruments and panels shall be grounded to the nearest plant equipment ground. Shielded cable shall have the shield grounded at one point for each loop; preferably at the point of origin. Signal wires shall not be run in conduit containing wire used for any other purpose.

B. The 4-20 mA, signal cable shall be minimum 18 gauge twisted shielded single pair tinned copper stranded conductors with teflon insulation. The pair shall have a minimum lay of 2 inches per twist. The shield shall be aluminum polyester with a 20 AWG stranded tinned copper drain wire and an overall teflon jacket rated at 300 volts. Color code shall be red and black. Cable shall be suitable for plenum, conduit and submerged service. Cable shall be equal to Belden No. 88760.

PART 3 - EXECUTION

3.01 GENERAL WIRING METHODS

A. Use only stranded conductors.

B. Use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet.

C. Place an equal number of conductors for each phase of a circuit in same raceway or cable.

D. Identification: All conductors shall be identified throughout the electrical system. For control and signal conductors use wire markers at all terminals and connections. Color code power circuit conductors as follows:

	120/208/240 Volt Systems	277/480 Volt System
Phase A	Black	Brown
Phase B	Red	Orange
Phase C	Blue	Yellow
Neutral	White	Grey
Ground	Green	Green

E. For conductors #8 AWG and larger color coding may be accomplished with 1-inch wide colored tape applied at each end of the conductor or at points where conductor is accessible so as to be visible inside the enclosure.

F. Neatly train and lace wiring inside boxes, equipment, and panelboards. Support to prevent conductor movement under fault conditions.

3.02 WIRING INSTALLATION IN RACEWAYS

A. Unless otherwise indicated, install all conductors in conduit.

B. Pull all conductors into a raceway at the same time. Thoroughly swab raceway system before installing conductors. Use wire pulling lubricate for all pulls. Do not exceed the manufacturers pulling tension.

C. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

D. Empty conduits shall contain a nylon rope with a minimum test strength of 200 pounds, coil 2 feet of rope at each end in panels or pullboxes.

E. Pulling in conduit - Do not install conductors until conduit system is completed. Inside of conduit shall be dry and clean. Use care in pulling wire to avoid damage. Use approved compounds. Do not pull thermoplastic wire at temperatures below 35°F.

F. Pulling in duct banks - Rod all individual conduits mechanically and install a pull line. A wire brush with diameter 1/2" greater than conduit bore diameter shall be drawn through each conduit. If all obstructions cannot be removed by this method, advise Engineer. Leave nylon pull line in each blank conduit.

3.03 WIRING CONNECTIONS AND TERMINATIONS

A. Avoid unnecessary splices. Splice only in accessible junction or outlet boxes.

B. Make connections to circuit breakers, disconnect switches, panel mains, etc. with solderless lugs.

C. Use mechanical connectors for low voltage splices, taps, fixture and motor connections.

D. Use insulated throat, spade type crimp on connectors for strap screw device terminals.

E. Where possible use connectors with integral, insulating covers. Otherwise tape uninsulated conductors and connectors to 150 percent of the insulation value of conductor.

F. Thoroughly clean wires before installing lugs and connectors.

G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

H. Taps and Lug Connections - Branch taps from mains shall be made with case copper alloy solderless connectors in a phenolic insulating case with at least 2 spring clip fasteners; Equal to: OZ type "PT", "PM" or "T", Burndy Insulated Service. Lug connections in switches and panelboards, etc., shall use 2 bolt or indent compression attachment cast copper clamps.

I. Splices - All splices shall be accessible and covered using pre-molded encasements such as Scotchlok spring type, Ideal wire nuts, or equal. Splices in manholes or underground boxes shall be watertight and made only by workmen experienced in such work. Splices may be made using mechanical connectors and wrapped using plastic tape equal to Scotch #33, Slipknow plastic tape

J. Terminations - All terminations shall be made to approved terminals and terminal blocks suitable for use with the type wire being used. Stranded control wire terminations shall be compression, self-insulated, spade type.

3.04 INSTALLATION OF CABLE OVER 600 VOLTS

A. The maximum allowable tension to be placed on cable during the installation procedure shall not exceed manufacturer's recommendations.

B. An approved pulling compound such as 1/16" layer of Albantonite shall be applied to the cables as they enter the conduit.

C. After the cable has been installed the contractor shall perform, and supply, 3 copies of test reports of a cable hi-pot acceptance test. Each cable shall be tested separately. A certified report of this test is required as is presence of the Engineer.

D. All new cables shall be tested for phase sequence and shall be permanently tagged with approved brass tags in each manhole. Tags shall show feeder designation and phase. After testing, all new cables shall be fire-proofed in every manhole.

E. All new connections, splicing and tapping in manholes shall be done using disconnectible type Elastimold taps and connectors.

F. New racks and insulators shall be provided in all existing manholes wherever existing cables are being replaced. All new racks shall be stainless steel.

G. All new cables in manholes shall be fire-proofed with an approved fireproofing tape. Cables shall be taped with minimum 50% overlap so that at any cross section of the cable there are at least (2) layers of the fireproofing tape.

H. Provide protective (lead) blankets for cover of existing energized feeders that may be present during the construction period.

3.05 FIELD QUALITY CONTROL

A. Inspect wire and cable for physical damage and proper connection.

B. Torque test conductor connections and terminations to manufacturer's recommended values.

C. Continuity Tests: Ring all conductors for continuity and replace any open conductors.

D. Low Voltage Ground Fault Tests: Meggar all feeder circuits for grounds. Compile and submit a list of meggar readings. Replace all conductors measuring less than 2 megohms to ground.

END OF SECTION 16120

SECTION 16130
BOXES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of outlet, pull and junction boxes. All boxes shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. All junction boxes, outlet boxes and pull boxes shall be accessible, either located in accessible spaces such as push up ceiling spaces, behind access panels, or with covers flush with finished surfaces. Where access panels are used, coordinate location with general construction trade. Do not locate covers of junction or pull boxes in finished rooms without review by the Engineer or unless otherwise indicated.

C. Provide a junction box, pull box or pull fitting at no more than 400 foot intervals in all conduit runs regardless of number of bends, and after every three successive 90° bends whether indicated on the Contract Drawings or not.

D. All junction boxes shall include an internal mounting backplate and numbered terminal strip(s) for splicing and/or tapping of conductors. Splicing of conductors in pull boxes is not allowed. Conductors shall be neatly harnessed and adequately supported to the backplate. Numbering and identification of terminals and conductors shall reveal the function of the conductors and shall follow the standard system established for the project. The Contractor shall provide a typewritten schedule identifying the conductor and terminal strip numbers.

E. Boxes and fittings shall be sized in accordance with NFPA 70, NEC, Article 370.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Boxes: Equal to: Appleton, Crouse Hinds, Raco, Steel City, Thomas & Betts.

2.02 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS-1; galvanized steel, with ½-inch male fixture studs where required.

B. Cast Boxes: Cast feralloy with galvanized or corro-free epoxy finish, deep type, gasketed cover, threaded hubs.

2.03 PULLBOXES, TERMINAL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS-1; galvanized steel. Boxes larger than 12-inches in any dimension shall be hinged.

B. Cast Metal Boxes: NEMA 250; Type 4, galvanized cast iron box and cover, neoprene gasket, stainless steel cover screws, UL listed as raintight. Provide flat-flanged type for surface mounting and outside flange recessed cover type for underground use. Boxes for sidewalk or other traffic areas to have appropriate duty cover with non-skid finish.

C. Corrosion Resistant (NEMA 4X) Boxes: Stainless steel with gasketed screw cover. For boxes larger than 12-inches in any dimension provide hinge on one (1) side and trunk latches on the other three (3) sides. Corrosion resistant boxes may be non-metallic (polyvinyl chloride (PVC) or fiberglass reinforced polyester (FRP) where indicated on the drawings.

D. PVC coated rigid steel boxes: Galvanized rigid steel with factory applied external 40 mil PVC coating and urethane interior coating.

E. Terminal blocks strips for terminal boxes shall be as specified in this Division.

2.04 HAZARDOUS AREAS - OUTLET, PULLBOXES, TERMINAL AND JUNCTION BOXES

A. Boxes in hazardous areas shall be cast iron with galvanized or corrofree epoxy finish, threaded hubs and cover, and shall comply with UL 886, ANSI C 33.27 and with NEC Class I, Div. I, Group D hazardous locations.

B. Terminal block strips for terminal boxes shall be as specified in this Division.

PART 3 - EXECUTION

3.01 COORDINATION OF BOX LOCATIONS

A. Provide boxes as shown on Drawings, and as required for splices, taps, wire pulling, and equipment connections.

B. Box locations shown on the Drawings are approximate unless dimensioned. Verify box locations prior to rough-in. Locate outlet boxes to permit handicap access per ANSI A117.1. Any outlet may be relocated by up to 10 feet before it is permanently installed without incurring additional cost.

3.02 INSTALLATION

A. Support boxes independently of conduit.

B. Boxes and all other wall mounted devices shall be solidly attached to structural members prior to installation of conduit. These devices shall be set true and plumb and installed with the use of stainless steel anchors and bolts. Wooden plugs are not permitted for securing equipment or conduit to concrete. All hardware items installed shall be stainless steel.

C. Conduit attachment to all electrical boxes and equipment shall be via threaded hubs in all areas. Double steel locknuts may be utilized in dry NEMA Type 1 or 12. Insulated-throat grounding

bushings shall be used on the end of each conduit termination. Grounding bushings shall be bonded to a ground bus or lug within the enclosure.

D. Fittings and boxes shall be provided with breather and drain fittings where indicated on the Contract Drawings or where required to facilitate draining.

E. Use multiple-gang boxes where more than one (1) device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

F. Align wall-mounted outlet boxes for switches, thermostats, and similar devices. Align adjacent devices at different elevations in one (1) vertical line. Set floor boxes level and flush with finish flooring material.

G. Provide cast outlet boxes in exposed, exterior, hazardous and wet locations.

H. Use PVC coated rigid steel boxes wherever PVC coated rigid steel conduit is indicated.

I. Box covers shall be of the same material and construction as the box.

END OF SECTION 16130

SECTION 16141
WIRING DEVICES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of wall switches, receptacles, device plates and box covers. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Catalog cuts.

1.03 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with NEMA standards and shall be UL approved.

B. Manufacturers include equal to:

1. Arrow Hart.
2. Bryant.
3. GE.
4. Hubbell.
5. Leviton Specmaster.
6. Pass and Seymour.
7. Sierra.
8. Crouse Hinds.
9. Appleton.

1.04 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 SWITCHES

A. General Purpose: NEMA WD-1; FS W-S-896; 20 amp, 120/277 volt, specification grade; horsepower rated; quiet type; back and side wiring provisions; toggle handle.

B. Hazardous Areas: Switches shall consist of a factory assembled and sealed combination general purpose switch in an explosion proof housing. The external operating mechanism shall consist of a wing-type handle having the on-off positions visible from front. The switch shall be rated in accordance with NEC for the area.

C. Corrosive and Outdoor Areas: Switches shall be 20 Amp pressure switch type with weatherproof/corrosion resistant neoprene plate. Switches shall be mounted in "FD" type copper-free aluminum or PVC mounting boxes.

D. Device Colors: Brown or black for specific use devices, otherwise as selected by the Engineer.

2.02 RECEPTACLES

A. General Purpose: Receptacles shall be NEMA WD-1; FS W-C-596, 20 AMP, 125 Volt, specification grade; impact resistant nylon face; back and side wiring provision; grounding screws; duplex.

B. Hazardous Areas: Receptacles shall be rated in accordance with NEC for the area and shall be factory sealed. Receptacle shall be designed so the plug must be inserted and turned before load is energized. Provide mounting box, sealing chamber and compatible plug.

C. Corrosive Areas: Receptacles shall be duplex; 20 Amp, NEMA 5-20R. Receptacle and plug shall be corrosion resistance; marine duty; polycarbonate with weatherproof lift cover.

D. Ground Fault Interrupter (GFI) Receptacles: Provide duplex specification grade GFI receptacles tripping at 5 milliamps; rated 20 amps, 120 volts, NEMA Configuration 5-20R. Use units meeting NEMA WD 1, fitting standard sized outlet boxes having provision for testing, and ivory in color. Use standard model where ground fault protection is needed. Do not use feed-thru model. Acceptable manufacturers: Equal to: Square D, General Electric.

E. Specific Use Receptacles: NEMA WD-1 or WD-5; type as indicated. For branch circuits serving a single device, match device rating to branch circuit rating.

F. Plug Caps: Male plug caps for receptacles shall be of the cord grip armored type with heavy phenolic housing of the same manufacturer as the receptacle.

G. Three Phase Receptacles and Plugs: Receptacles shall be suitable for 480V, 3 phase, 4 wire service with ampere rating as specified. The grounding pole shall be permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the

plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, a gasketed screw-type, weathertight cap with chain fastener and one plug.

2.03 WALL PLATES

A. Damp Area Cover Plates: Unbreakable nylon, Lexan, or noryl, smooth finish, color to match devices.

B. Dry Area Device Plates: Type 302 stainless steel, 0.030 inch thick minimum, satin finish.

C. Weatherproof Cover Plate: Gasketed cast metal with hinged, gasketed, spring loaded device covers.

D. Lockable Cover Plate: Equipment local disconnect (power or control circuits) with padlockable, NEMA rated for the location, equal to Appleton FSK-IVS, Carlon E98TSL or Arrow Hart 7949.

2.04 PLUG STRIP

A. Plug strip shall be manufactured of sheet steel with the receptacles mounted on front cover. The front cover shall be removable.

B. Disconnect Switches:

1. The switches shall have switchblades, which are fully visible in the "OFF" position when the switch door is open. All current carrying parts shall be plated to resist corrosion and promote cool operation. Switches shall have removable arc suppressors where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL listed for 60°C or 75°C copper wires.

2. The switches shall be quick-make, quick-break such that, during normal operation of the switch, the operation of the contacts shall not be capable of being restrained by the operating handle after the closing or opening action of the contacts has started. The operating handle shall be an integral part of the box, not the cover. Provisions for padlocking the switch in the "OFF" position with at least three locks shall be provided. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the "ON" position, and to prevent closing of the switch mechanism with the door open. The handle position shall indicate whether the switch is "ON" or "OFF".

3. The switches shall be furnished in a NEMA rated enclosure as indicated on the Drawings and/or as required for the specific application and approved by the Engineer.

4. The discónnect switches shall be 600 volt, ampere and horsepower rated, fusible or non-fusible, 3 pole, heavy duty front-operated safety switch with ground lug, and auxiliary electrical contacts, Equal to: Square D, Class 3110, General Electric or Siemens.

5. Ratings shall be as shown on the Contract Drawings.

2.05 ENCLOSED CIRCUIT BREAKERS

A. The breakers shall be thermal-magnetic, molded case circuit breakers with instantaneous pick up adjustment. The circuit breakers shall be UL and CSA listed, IEC 157-1 rated, meet NEMA Standard AB1-1975 and Federal Specification W-C-375B/GEN.

B. The circuit breakers shall have overcenter toggle-type mechanisms, providing quick-make, quick-break action and shall be calibrated for operation in an ambient temperature of 40oC. The circuit breakers shall have trip indication by handle position and shall be trip-free. The circuit breakers shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. A push-to-trip button shall be provided on the cover for mechanically tripping the circuit breaker. The circuit breakers shall have reverse connection capability and be suitable for mounting and operating in any position.

C. Lugs shall be UL listed for copper conductors and installation of compression type lugs.

D. NEMA type enclosures shall be furnished fabricated from sheet steel, which conforms to UL 50. The enclosure shall be given an electrodeposited, baked enamel finish. Color shall be selected by the Engineer at the time of shop drawing submittal. Padlocking provisions shall be provided to allow locking the circuit breaker in the "OFF" position. The enclosure and breaker assembly shall be UL listed and service entrance rated as required.

E. Ratings shall be as indicated on the Contract Drawings.

2.06 MANUAL MOTOR STARTERS

A. Manual starters shall be furnished and installed as specified herein, as shown on the Contract Drawings and as required to properly control and protect the motor controller. Motor controllers shall be of the manual type with thermal overload.

B. Manual starters shall be ampere and horsepower rated and shall be either one pole at 115 VAC or 2/3 pole at 230/460 VAC as required or as otherwise acceptable to the Engineer.

C. Provide pilot lights where required and heater elements of rating based on motor nameplate data.

D. Each starter shall be equipped with either a pushbutton or toggle operator and a reset device accessible without opening the enclosure.

E. The starters shall be furnished in a lockable NEMA rated enclosure as indicated on the Drawings and/or as required for the specific application and approved by the Engineer. Provide appropriate wall plate(s) for flush mounted application(s).

F. The manual starters shall be equal to Square D, Class 2510, General Electric or Siemens.

2.07 MAGNETIC MOTOR STARTERS

A. Magnetic starters shall be of the combination circuit breaker type except as shown on the Contract Drawings and in accordance with the following for 600V and below applications.

B. Unless otherwise indicated, the Contractor shall provide non-reversing, full voltage, across-the-line mechanisms, closed by coil action, an opened by gravity. Starters shall be equipped with 120V coils and self-contained control transformer for 480-volt circuits unless otherwise indicated.

C. Each combination starter shall use a thermal-magnetic type molded case circuit breaker as the unit disconnect. Instantaneous trip, magnetic only motor circuit protector type breakers may be utilized as approved by the Engineer. All breakers shall have a short circuit interrupting capacity of 65,000 amps RMS at 480 VAC or as indicated otherwise on the Contract Drawings. All starters shall use NEMA rated contactors (NEMA size 1 minimum).

D. The overload relays shall be solid-state type and provide proper protection for T-frame and U-Frame motors and shall meet NEMA Class 10 tripping characteristics. Overload relays shall be NEMA Class 20 or 30 where indicated or directed by the Engineer. The overload relays shall trip within the NEMA defined timing range under locked rotor condition and shall be designed to provide phase failure, phase unbalance and ground fault protection. They shall be ambient compensated and shall include an isolated Form-C contacts. Overload trip indication shall be provided. The relays shall be factory inspected and calibrated so that a minimum acceptance accuracy level of + 5% is maintained. The relays shall have a field adjustable tripping current range of approximately 3 to 1.

E. When provided, control circuit transformers shall include two primary fuses and one secondary fuse (in the non-grounded secondary conductor). The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads plus 20% spare burden capacity.

F. When a unit control circuit transformer is not provided, the disconnect will include an electrical interlock for disconnection of externally powered control circuits.

G. Auxiliary control circuit interlocks shall be provided where indicated. Auxiliary interlocks shall be field-convertible to normally open or normally closed operation.

H. The starters shall be furnished in a lockable NEMA rated enclosure as indicated on the Drawings and/or as required for the specific application and approved by the Engineer.

I. The magnetic motor starters shall be equal to Square D, or Cutler-Hammer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Secure devices to outlet boxes without depending on device plates to pull them tight. Install a bonding jumper between all devices and outlet boxes.

B. Install switches with off position down; and receptacles with grounding pole on bottom.

C. For cord and plug connected equipment, coordinate receptacle configuration with equipment supplied.

D. Install device plates on switch, receptacle, and blank outlets. Use jumbo size plates for devices installed in masonry walls.

E. Mounting heights from the finished floor to the centerline of the various boxes and equipment shall be as follows except as otherwise indicated on the Contract Drawings.

END OF SECTION 16141

SECTION 16150
ELECTRIC MOTORS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of all electric motors. All electric motors shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.

C. Related Work Specified Elsewhere:

1. All motor driven equipment sections except submersible motors and DC motors.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Expected and guaranteed minimum efficiency values and power factor for operation at 100, 75, 50, 25 and 0 percent load.
2. Type of enclosure.
3. Overall dimensions and proposed size and location at terminal junction boxes.
4. Noise level guarantee.
5. Bearing life certificate.
6. Starting characteristics, including torque and lock rotor current.
7. Motor nameplate data.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEMA MG-1.
2. UL 674.
3. UL 1004.

B. Efficiency: High efficiency; guaranteed minimum values determined in accordance with IEEE Standard 112, Test Method B including stray load loss as follows; or as specified in other Divisions:

	------Synchronous RPM------			
HP	3600	1800	1200	900 & less
15 - 49	90%	91%	90%	88%
50 - 99	92	93%	92%	90%
100 & Above	94%	95%	94%	92%

NOTE: Provide the manufacturer's highest available design for motors less than 15 horsepower and for motors specified with special torque (NEMA design C or D) or duty cycle (intermittent operation).

1.04 QUALITY STANDARDS

A. Motors shall be designed, manufactured and tested in accordance with the latest revisions of the following standards:

1. NEMA Standards.
2. IEEE Standards.
3. ANSI Standards.
4. UL Standards.

B. Manufacturers offering products that comply with these Specifications include:

1. General Electric.
2. Reliance.
3. U. S. Motors.
4. Or equal.

1.05 PERFORMANCE

A. Motors shall be adequate for long periods of inactivity and the effects of an atmosphere that is made corrosive by traces of chemicals normally present in a wastewater treatment plant, and environmental conditions existing at the plant site such as high humidity, insects, plant life, fungus, rodents, etc. When motors are to be inactive in excess of 30 days, the Contractor shall maintain the bearings and rotate the shaft twice a month for the duration of the inactive period. The insulation of all drip-proof and weather-protected motors shall be specially designed for use in atmospheres containing moisture and corrosive fumes, which are normally encountered in wastewater treatment plants.

PART 2 - PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the

manufacturers' latest standard design that conforms to these Specifications, unless otherwise indicated:

B. Unless otherwise specified, all ac motors shall be squirrel cage induction type, rated for continuous duty at service conditions specified herein.

C. The connected load (maximum horsepower required) of each motor shall not exceed its nameplate horsepower rating (exclusive of service factor) under any anticipated operating condition. All motors shall have a service factor of 1.15.

D. Motors with synchronous speeds of 1,800 rpm or higher shall have full load current not exceeding the values in NEC Table 430-150. Motors with synchronous speeds of 1,200 rpm shall have full load current not exceeding 110 percent of the above values.

E. Motors shall be rated for a 40 degrees C ambient temperature unless specifically indicated otherwise.

F. Motors shall have a grounding terminal in the motor terminal junction box. The bolt which attaches the grounding lug to motor terminal junction box shall not be used for any other purpose (such as mounting the box to the motor).

G. Drip-proof and weather protected motors shall have 316 stainless steel screens over all openings.

H. Motors specified as totally enclosed and rated 5 horsepower or less may be either fan ventilated or nonventilated. Motors specified as totally enclosed and rated over 5 horsepower shall be fan ventilated.

2.02 MOTOR CONDUIT BOXES

A. Conduit boxes shall be NEMA 4 made of cast iron and shall be of adequate size to permit terminating leads. It shall be possible to rotate these boxes in steps of 90 degrees. Conduit box shall be of adequate size and shall have a sufficient number of correct size openings to accept all required conduits. (See Electrical Drawings for size and number of conduits).

B. Torque Classification: Motors shall match the torque requirements of the driven equipment.

2.03 MOTOR EFFICIENCY AND POWER FACTOR

A. Motors shall be NEMA Design B, of the energy efficient type unless otherwise noted. The motor guaranteed minimum efficiency at full load shall not be less than the values shown in Table 1, in 1.03 B. For exceptions see 2.06E.

B. The guaranteed minimum efficiency shall be submitted with the shop drawings. Any motor not meeting the minimum efficiency shall be rejected. If the motor is found in the field to be of a lower efficiency than specified, it shall be replaced with a new motor meeting these specification and efficiency requirements.

2.04 MOTORS OPERATED FROM ADJUSTABLE SPEED DRIVE CONTROLLERS

A. Provide motors with sufficient nameplate rated capacity to drive the specified equipment and to provide the specified margin between system capacity and connected load after any motor

derating required to allow for extra heating in the motor due to the harmonic content in the voltage supplied by the controller. The adjustable frequency drive system supplier shall be responsible for a properly sized and completely compatible drive system. For small PWM drives, motor insulation system shall be suitable for volts/per microsecond = 1,200 maximum. For large current source drives, motors shall be compatible with the drive.

2.05 RATING

A. Horsepower (HP): As noted. Where no value is noted, match the requirements of the driven equipment.

B. Phase:

1. Less than ½ HP: Single Phase.
2. ½ HP and Larger: Three-Phase.

C. Voltage:

1. Single Phase Motors: 115/230 volt, 1 phase, 60 Hz.
2. Three-Phase Motors: 460/230 volt, 3 phase, 60 Hz.

D. Speed, Revolutions Per Minute (RPM): As noted. Where no value is noted, match the requirements of the driven equipment.

E. Torque and Starting Current: Exceptions: Provide NEMA design C or D where required by the driven equipment. Unless specifically noted NEMA design A motors are not acceptable.

F. Insulation and Temperature Rise: Except as noted, Class F insulation with temperature rise, measured by resistance, corresponding to the insulation class in accordance with NEMA standards for operation in a 40 degree C ambient. Exception: For motors used with variable frequency drives provide Class F insulation with temperature rise in accordance with Class B limits.

2.06 CONSTRUCTION

A. Enclosure: Totally enclosed fan cooled (TEFC) cast iron frame with stainless steel drain/breather unless otherwise noted.

B. Windings: Copper.

C. Starting: As noted.

D. Multispeed motors: Two winding type unless otherwise noted.

2.07 ACCESSORIES

A. Provide lifting eyes for 182 and larger frame size.

B. Where noted provide normally closed thermostat for winding protection.

C. Where noted provide 120 volt, single phase space heater. Size heater to increase motor temperature approximately 10 degrees C above ambient. Provide power and motor space heaters for all pumps located in damp, wet, or outdoor locations, including but not limited to all submersible pumps located in the diversion pump station and the jet mixing pump station.

D. Provide six 100-ohm platinum RTDs (2 per phase) with the stator windings wired to a separate terminal box for 575 volt motors used with VFDs. Provide a temperature switch in the stator winding for 460 V motors to be used with VFDs or wherever specified in the equipment specifications.

E. Nameplate: Permanently affixed and stamped so as to permit recovery of the nameplate data in the event the nameplate is painted over.

2.08 SEVERE DUTY MOTORS

A. Motor types designated as severe duty shall have the following minimum features as defined by NEMA:

1. Totally enclosed, mill and chemical duty.
2. Cast iron frames and end shields.
3. Stainless steel hardware, drains, breathers and nameplates.
4. Capillary type drains/breathers.
5. Nonsparking, corrosion-resistant fans.
6. Gasketed conduit boxes.
7. Nonhygroscopic epoxy varnish sealed windings.
8. Extra dips and bakes of insulating varnish for moisture protection of windings.

2.09 SEVERE DUTY SUBMERSIBLE MOTORS

A. Motor type designated as severe duty submersible motor shall have the following features:

1. Shell type design housed in an air-filled or oil-filled water tight chamber.
2. UL listed for explosion-proof motors, in accordance with UL 674 for Class I, Group D hazardous atmosphere.

2.10 INVERTER DUTY MOTOR

A. Motors connected to variable frequency drives shall be "Inverter Duty Motor"

2.11 MOTOR TYPES

A. Motor types indicated in the detailed equipment specifications are defined as follows:

1. Type 1: Horizontal, single speed, protected standard duty motor.

Bearing Life	50,000 hours, ABMFA B-10

2. Type 2: Horizontal, single speed, severe duty motor. The motor shall have:

Bearing Lubrication	Grease, positive lubrication system.
Bearing Life	50,000 hours, ABMFA B-10

3. Type 3: Vertical, solid shaft, single speed, severe duty motor. The motor shall have or be suitable for:

Frames and Endshields	Cast iron, NEMA Style P-Base
Motor Modifications	
Bearing Life	25,000 hours

4. Type 4: Horizontal, single speed, severe duty submersible motor. The motor shall have:

Bearing Lubrication	Grease, positive lubrication system.
Factory pre-wired, with thermal detector and moisture detector	
Bearing Life	25,000 hours

5. Type 5: Horizontal, single speed, explosion proof motor for Class I, Group D Hazardous Atmosphere. The motor shall have:

Motor Modifications	Breather/drain device Frame temperature thermostat, normally closed contact

PART 3 - EXECUTION

3.01 GENERAL

A. All motors shall be designed, manufactured, and tested in accordance with the latest edition of NEMA MG 1. All motors shall be able to start, accelerate, and drive the design load of the driven equipment without exceeding any of the specified design requirements.

B. Finish shall be manufacturer's standard gray or ANSI 61 gray over a primer and rust inhibitor, unless detailed under motor types and in accordance with 09900 Section, Painting.

3.02 INSTALLATION

A. Verify clearances and alignment prior to operation.

B. Lubricate in accordance with the manufacturer's instructions.

C. Check rotation and correct as necessary.

END OF SECTION 16150

SECTION 16160
CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of hinged cover enclosures, cabinets, terminal blocks and accessories. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data.
2. Drawings for equipment panels including schematic diagram, wiring diagram, outline drawing and construction diagram as described in NEMA ICS-1.

1.03 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with the NEMA standards and shall be UL approved.

B. Manufacturers offering products that comply with these specifications include:

1. Crouse-Hinds.
2. Appleton.
3. Hoffman.
4. Weigmann.
5. Or equal.

PART 2 - PRODUCTS

2.01 GENERAL

A. Enclosure type shall be as follows:

1. Indoors, dry location: NEMA 12.
2. Outdoors and corrosive areas: NEMA 4X.
3. Hazardous areas: NEMA 7.

2.02 HINGED COVER ENCLOSURES

A. Construction: Comply with NEMA 250; 12 gauge steel, no knockouts, wall mounted or free standing as indicated. Free standing enclosures are minimum 20-inches deep. Unless otherwise noted, enclosures shall be as required in 16000-2.01.

B. Finish: Baked on enamel over a rust inhibitor for NEMA 1.

C. Covers: Continuous hinge, held closed by hasp and staple for padlock. Furnish three-point latch for free standing enclosures.

D. Panel for Mounting Terminal Blocks or Electrical Components: 14 gauge steel, white enamel finish interior.

2.03 CABINETS

A. Cabinet Boxes: Code gauge galvanized steel.

B. Cabinet Fronts: Steel, surface type with concealed trim clamps, concealed hinge and flush lock keyed to match branch circuit panelboard; finish in gray baked enamel.

2.04 TERMINAL BLOCKS AND ACCESSORIES

A. Terminal Blocks: NEMA ICS-4; UL listed.

B. Power Terminals: One-piece phenolic closed-back type, with binding screw or stud terminal connectors, rated 600 volts, 30 amperes.

C. Signal and Control Terminals: Modular construction type, channel mounted with marking strip; screw terminals, rated 600 volts.

2.05 FABRICATION

A. Shop assemble enclosures and cabinets housing terminal blocks or electrical components in accordance with NEMA ICS-6.

B. Selectors and Indicators: Door mounted for indoor enclosures. For outdoor enclosures provide a separate, hinged, inner door (dead front panel) for device mounting.

C. Lace conductors with plastic ties to present a neat and orderly appearance. Provide nylon wrapping to protect conductors crossing hinges.

D. Provide conduit hubs on enclosures.

E. Provide protective pocket inside front cover with control wiring and panel layout diagrams.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install cabinets and enclosures plumb, anchor securely to wall and structural supports at each corner with top of cabinet 6 ft. 6 inches above finished floor. Install cabinet interior after all conduit connections are completed.

B. Install all surface mounted cabinets at least 1 (one) inch off wall. Install supports in such a manner as to not block vertical flow of air in back of cabinet.

C. Provide accessory feet for free-standing equipment enclosures.

END OF SECTION 16160

SECTION 16175
INSTRUMENT TRANSFORMERS, METERS, SWITCHES AND ACCESSORIES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of accessories for low voltage switchgear, 15kV switchgear, low voltage motor control assemblies and switch boards. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data indicating the general features and dimensions of devices.
2. Burden, accuracy class and ratio data for instrument transformers.
3. Operation and maintenance manuals.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI C37.20.
2. ANSI C39.1.
3. ANSI C57.13.
4. NEMA STD.11.

PART 2 - PRODUCTS

2.01 INSTRUMENT TRANSFORMERS

A. General:

1. Instrument transformers shall be molded dry-type in accordance with ANSI C57.13. Transformer volt-ampere rating shall be suitable for carrying the specified load without overheating or exceeding the permissible accuracy for the transformer.

B. Potential Transformers:

1. Potential transformers shall have an ANSI accuracy class of 0.3. They shall be equipped with current limiting fuses.

C. Current transformers:

1. Current transformers shall be furnished with the specified ratios. Transformers shall be 5 ampere secondary bar or window type with single secondary winding and secondary shorting device. The accuracies shall conform to ANSI C37.20.

2.02 PANEL METERS

A. All indicating meters shall be 4-½-inch square, semi-flush mounted, dust tight switchboard type. Moving elements provided with zero adjustments and the movement shall be taut-band with an accuracy of plus or minus 1 percent of full scale. The case shall be black. The scale shall be white with black markings. The length of the scale shall be greater than 7 inches over a deflection angle of 250 degrees. The meters shall be manufactured in accordance with applicable requirements of ANSI C39.1

2.03 INSTRUMENT SWITCHES

A. Control and instrument switches shall be heavy-duty oil tight units rated 20 amperes at 600 volts. Instrument switches shall be provided with contact blocks and positions specified. Switches shall be of the rotary-cam type and contacts shall have positive wiping action of silver-to-silver contact buttons, 5,000,000 operation mechanical life. Switches shall be provided with escutcheon plates and pistol-grip handles. Switches shall be General Electric, SBM, Cutler-Hammer, W-2; or equal.

B. Voltmeter and ammeter switches shall have four positions with the escutcheon legend as follows:

Voltmeter	OFF	1-2	2-3	3-1
Ammeter	OFF	Phase A	Phase B	Phase C

2.04 KEY INTERLOCK

A. Where specified, the key interlock shall consist of two or more identically keyed brass bolt locks. The bolt on the lock shall prevent the operation of the electrical equipment. One brass key shall be provided for each group of identical locks. The key shall be held captive when the lock is positioned to allow equipment operation.

2.05 INDICATING LIGHTS

A. Switchboard indicating lights shall be register type of the voltage specified. Bulbs shall be telephone type with a slide base.

2.06 NAMEPLATES

A. Nameplates shall be provided as specified in Section 16050, Paragraph 2.11.

2.07 EXECUTION

A. All accessories and devices shall be installed per the switchgear manufacturer's instructions.

END OF SECTION 16175

SECTION 16195
ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations.

1.03 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of product specified.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate installing electrical identification after completion of finishing where identification is applied to field-finished surfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. American Labelmark Co., Labelmaster Subsidiary.
2. Brady USA Inc.; Industrial Products Div.
3. Carlton Industries, Inc.
4. Champion American, Inc.
5. Cole-Flex Corp.
6. Ideal Industries, Inc.
7. Markal Corp.
8. National Band & Tag Co.
9. Panduit Corp.
10. Raychem Co.

11. Seton Name Plate Co.

12. Standard Signs, Inc.

2.02 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for a specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Engraving stock, melamine Plastic laminate, 1/16 inch (1.6 mm) minimum thickness for signs up

1. Engraved Legend: White letters on black face.

2. Punched for mechanical fasteners.

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for the application. ¼-inch (6.4 mm) grommets in corners for mounting.

D. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.03 WIRE MARKERS

A. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The figures shall be 1/8 inch high. Sleeves shall be yellow or white tubing, sized to fit the conductor insulation. The sleeves shall be shrunk to fit the conductor with hot air after installation. They shall be TMS Thermofit Marker System by Raychem Co., sleeve style wire marking system by W. H. Brady Co., or equal. Adhesive strips are not acceptable. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

2.04 RACEWAY MARKERS

A. Raceway markers shall be 0.036 inch minimum thickness, solid metal tags with raceway number stamped in 3/16 inch minimum height characters. Such tags shall be attached to the raceway with heavy duty tie wraps. Alternatively, aluminum wrapped bands, approved for the purpose, may be employed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Install labels at locations for best convenience of viewing without interference with operation and maintenance of equipment.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and designations used for electrical identification with corresponding designations used in the Contract Documents or required by codes and standards. Use consistent designations throughout the Project.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

E. Self-Adhesive Identification Products: Clean surfaces of dust, loose material and oily films before applying.

F. Install circuit identification labels on faceplates of receptacles, outlet, telephone/data outlets, etc. Use pressure sensitive, self-adhesive plastic labels. Identify supply panel and circuit on the label.

G. Install Circuit Identification Labels on Boxes: Label externally as follows:

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

H. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where multiple lines installed in a common trench or concrete envelope do not exceed an overall width or 16 inches (400 mm), use a single line marker. Install line marker for underground wiring, both direct buried and in raceway.

I. Color-Code Conductors: Secondary service, feeder, and branch circuit conductors throughout the secondary electrical system.

1. 208/120 Volt System: As follows:
   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   d. Neutral: White.
   e. Ground: Green.
2. 480/277 Volt System: As follows:
   a. Phase A: Yellow.
   b. Phase B: Brown.
   c. Phase C: Orange.
   d. Neutral: Gray.
   e. Ground: Green.
3. Factory-apply color the entire length of the conductors, except the following field-applied, color-coding methods may be used in lieu of factory-colored wire for sizes larger than No. 10 AWG. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply the last two (2) turns of tape with no tension to prevent possible unwinding. Use 1 inch (25

mm) wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.

J. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4 inch (6.4 mm) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Fasten tags with nylon cable ties; fasten bands using integral ears.
3. Apply tags or bands such that all conductors in each circuit are included.

K. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
3. Multiple Control and Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking tape.

L. Wire and Cable Identification

1. Every power wire, power cable, control wire, control cable, instrumentation wire and cable shall be permanently identified at every termination point with a wire marker.
2. Use wire marker as described in 2.03 above. Mark with circuit wire number, control diagram number, loop number, equipment number, etc. as applicable.

M. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where required by Code or indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install arc-flash hazard warning signs per NEC 110.16. Install engraved, plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency-Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8 inch (9 mm) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

N. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide a single line of text with 1/2 inch (13 mm) high lettering on 1-1/2 inch (38 mm) high label: where 2 lines of text are required, use

lettering 2 inches (51 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment.

a. Panelboards, electrical cabinets, and enclosures.
b. Power transfer equipment.
c. Contactors.
d. Transformers.
e. Fire-alarm master station or control panel.
f. Security-monitoring master station or control panel.
g. Telephone Backboard.
h. Data Backboard.
i. Television Master Station.

2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

3. Raceway Numbering Convention

Raceway Prefix	Type of Function
C	Control and/or 120V or less power
H	Power above 600V
N	Pneumatic Tubing
P	Power 208V to 600V
S	Low level signal (less than 90 volts communication or less than 30 volts instrumentation)
X	Spare

a. The Raceway Prefix shall be followed by the panel designation where the raceway originates. Where there is more than one raceway to a particular panel, a number suffix is added to distinguish the raceway.

Example:
C-RIOXXX-1 C=Control RIOXXX= Remote I/O Panel XXX 1= Conduit #1
C-RIOXXX-2 C=Control RIOXXX= Remote I/O Panel XXX 2= Conduit #2
S-RIOXXX-1 S=Signal RIOXXX= Remote I/O Panel XXX 1= Conduit #1
P-LPXXXX-1 P=Power LPXXXX= Lighting Panel XXXX 1= Conduit #1
P-LPXXXX-2 P=Power LPXXXX= Lighting Panel XXXX 2= Conduit #2

b. When multiple raceways exit a pull box, the raceways shall maintain the Numbering Convention assigned to the main raceway entering the pull box.

Example:
C-RIOXXX-1 2" – (32 - #14) (2" Conduit w/ 32 #14 conductors entering the pull box)
C-RIOXXX-1A ¾" –(4 - #14) (3/4" Conduit w/ 4 #14 conductors exiting the pull box to LSL/LSH-XXX-1)
C-RIOXXX-1B ¾" –(4 - #14) (3/4" Conduit w/ 4 #14 conductors exiting the pull box to LSL/LSH-XXX-2)
C-RIOXXX-1C ¾" –(8 - #14) (3/4" Conduit w/ 8 #14 conductors exiting the pull box to Control Panel CP-XXXX)

c. The conductors within a raceway shall be identified with the raceway number followed by the terminal number the conductor is terminated on inside the equipment.

Example:
C-RIOXXX-1-1560 (Wire number C-RIOXXX-1-1560 routed inside raceway (conduit) C-RIOXXX-1, terminated inside Remote I/O Panel XXX on terminal 1560.)
C-RIOXXX-1-1561 (Wire number C-RIOXXX-1-1561 routed inside raceway (conduit) C-RIOXXX-1, terminated inside Remote I/O Panel XXX on terminal 1561.)

END OF SECTION 16195

SECTION 16215
ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish, install and test the electrical power monitoring system as shown on the Drawings in accordance with these Specifications.

1.02 SUBMITTALS

A. Submit to the Engineer, in accordance with the General Conditions, the Special Conditions, and Division 1, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following:

1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits, and metering layouts. Indicate all options, special features, ratings, and deviations from the specifications.
2. Product data sheets and catalog numbers for components. List all options, adjustments, and accessories furnished specifically for this Project.
3. Manufacturers standard wiring diagrams for metering relay, power and control circuits in accordance with the NEMA wiring class specified. Show all field devices, switches, lights, wire, terminal numbers, etc.
4. Instruction and renewal parts books.
5. Itemized list of spare parts furnished specifically for this Project, including quantities, description, and part numbers.
6. Test and inspection reports.
7. Complete bill of materials list.

1.03 REFERENCE STANDARDS

A. Power monitoring system shall be designed, built and tested in accordance with the latest editions and revisions of NEMA Standards and Underwriters' Laboratories Standards. Equipment shall conform to ANSI test standards and the requirements of the National Electrical Code.

1.04 QUALITY ASSURANCE

A. The equipment furnished under this Section shall be the product of a Manufacturer who has produced this same type of equipment for a period of at least ten (10) consecutive years.

B. Power monitoring system shall be designed, assembled, and tested by the Manufacturer of the equipment included in the assembly.

C. All units and sections shall be UL labeled.

PART 2 - PRODUCTS

2.01 RATING

A. Service: 480 Volts, three-phase, three-wire (or four-wire where indicated on the Drawings), 60 Hertz.

B. Power monitoring system, including devices, shall be designed for continuous operation at rated current in a 40 degrees C ambient temperature.

2.02 CONSTRUCTION

A. General:

1. The general arrangement of the power monitoring system is shown on the Drawings. The power monitoring system shall be manufactured by one of the following companies:
   a. Cutler-Hammer/Westinghouse
   b. General Electric
   c. Square D Co.
   d. Siemens.

2.03 COMPONENTS

A. Instrumentation and Metering:

1. Instrument control switches: 600 Volts switchboard type, rated 20 Amperes continuous, with black molded phenolic escutcheon plates, white characters, Square D or equal.

2. Instrumentation transformers: Indoor, 600 Volts, butyl rubber molded, metering class designed in accordance with ANSI and NEMA standards. Window type current transformers, with burden capacity as low as 50 VA, may be used where such capacity is sufficient. Current transformer accuracy ratings shall be at least equal to NEMA standard requirements for the particular applications.

3. Power circuit monitors shall be provided on the main breakers as indicated in the single line diagrams. The power circuit monitors shall replace the standard voltmeters and ammeters and shall be General Electric PQM-II/EPM, Eaton IQ DP-4000, Square D Company's "Power Logic", or equal, with features as specified below.

4. Elapsed time hour meters: Five digit, non-reset type, with 120 Volts synchronous motor.

B. Power Monitors:

1. Microprocessor based metering: At each circuit location shown on the Drawings, furnish a digital microprocessor based metering device capable of monitoring and displaying the functions listed below. The device shall provide the status input functions indicated and the capability to communicate data to a centralized monitoring system via a data highway network. The device shall be UL listed.

2. Metering Functions:
   a. The digital AC Instrumentation Package shall be capable of measuring, calculating and directly displaying on the front panel display the following information:
      i) Volts on each phase plus average of all three phases.
      ii) Current on each phase plus average of all three phases.
      iii) Neutral or ground current.
      iv) Frequency.
      v) Power Factor.
      vi) KVA.
      vii) KVAR.
      viii) KW.
      ix) Total KWH as an accumulating total, providing bi-directional (import/export) indication.
      x) Amps Demand.

3. Monitoring and Control Functions. These monitoring and control functions are required for switchgear applications, but not for switchboard applications:
   a. Provide eight self-powered digital status inputs to monitor the following points:
      i) Circuit breaker OPEN status.
      ii) Circuit breaker CLOSED status.
      iii) Circuit breaker TRIPPED status.
      iv) Circuit breaker OUT OF SERVICE (withdrawn) status.
   b. Provide one auxiliary analog input (selectable 0-20 mA or 4-20 mA), which can be used to measure an external variable such as transformer temperature, air temperature, or battery voltage.
   c. Provide one auxiliary analog output (selectable 0-20ma or 4-20ma) proportional to any measure parameter.
   d. Provide three Form C dry contact control relay outputs rated 277 VAC or 30 VDC at 10 Amp maximum load current, that can each function as:
      i) Setpoint relays that operate as a function of any measured parameter for demand, power factor, or load control. Seventeen programmable setpoints shall each have programmable operate and release limits and time delays on operate and release. Relays shall provide selectable pulse mode or tach mode operation.
      ii) Remote control relays operated by commands via the communications port.
      iii) Breaker trip relay (over/under volt, volt unbalance, phase reversal, current unbalance, over/under frequency).
      iv) KWH or VARH pulse output relay.
      v) Alarm relays.

4. Operational Features:
   a. Provide the following operational features:
      i) True RMS measurements.
      ii) Connect directly to PTs and CTs.
      iii) Provision for a fourth current input for measurement of ground or neutral current.

iv) 300 Amperes, one second surge protection on all four current inputs.

v) Three-field, 20 character, high visibility 0.4 inch character height vacuum-fluorescent display with a programmable time out feature.

b. Store in non-volatile memory the following:

i) A time-stamped alarm and event log up to 50 events which records event date, time (to 1 second), event type and value for all over/under limit conditions, all status input activity and all relay operations. Log shall be read via the communications port.

ii) A time-stamped minimum/maximum log, which records the value of any parameter exceeding the previous highest or lowers value recorded. Log shall be read from the front panel display or via communication port.

iii) A time-stamped snapshot (historical) log, with a 100 snapshot capacity and user-definable snapshot interval from 1 second to 400 days which records snapshot values for Average Volts, Average Amps, KW, KVAR, KW Demand, Power Factor, Frequency, KWH, KWH Reverse, KVARH and Auxiliary Volts Input. Log shall be read via the communications port.

iv) All setup data.

5. The device shall be field programmable as follows:
   a. Volts scale, volts mode (wye, delta, single phase), amps scale, baud rate and the relay operation shall be programmable from the front panel.
   b. All parameters above, plus additional alarm/event parameters shall be programmable via the communication port using a portable terminal or a computer.
   c. The programming shall be password protected.
6. Waveform Capture:
   a. Provide waveform capture capability allowing any of the eight voltage and current input channels to be digitally sampled 256 samples/60 Hertz cycle. Waveform capture shall be initiated using commands made via the communications port. Waveform capture data shall be made accessible via the communications port.
7. Data Communication:
   a. Provide a serial communication port which has:
      i) Switchable RS-232C and RS-485 capability.
      ii) Addressable polling of multiple units.
      iii) Packet transmission.
      iv) Selectable transmission at 300 to 19,200 baud.
   b. Provide all communication cables to interconnect monitors with the electrical equipment.

2.04 SURFACE PREPARATION AND SHOP COATINGS

A. All non-current carrying metal parts of the assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pretreatment to inhibit rust.

B. Indoor equipment shall be finish painted with one coat of Manufacturers standard electrocoated, heat cured enamel. Color shall be ANSI-61 light gray.

2.05 SHOP TESTING

A. Perform Manufacturers standard production testing and inspection in accordance with NEMA and ANSI standards. If requested by the Engineer, the Manufacturer shall submit certified copies of test results.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install the equipment in accordance with the Manufacturers instructions.

B. Touch-up damaged point's finishes.

3.02 FIELD TESTING

A. Make the following minimum tests and checks before the Manufacturers representative is called in for testing and adjustment

1. Remove current transformer shunts after completing secondary circuit.
2. Check polarity and continuity of metering and relaying circuits.

B. In the event of an equipment fault, notify Engineer immediately. After this cause of the fault has been identified and corrected, the Contractor, the Engineer, and the equipment Manufacturers factory service technician shall conduct a joint inspection of the equipment. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

3.03 ADJUSTMENT

A. The Manufacturer shall provide the services of a factory trained service technician for the time period specified in Section 16010. The first trip shall be coordinated with the equipment start-up. The second trip shall include any necessary follow-up or punch list work, and shall also include instructions to the Owner or to his designated personnel. The Manufacturer's service technician shall demonstrate and test all operation features of the installed equipment to the satisfaction of the Owner. Submit a certified copy of the field inspection to the Engineer. No equipment is to be energized without the approval of the Engineer.

3.04 CLEANING

A. Remove all rubbish and debris from inside and around the enclosure. Remove dirt, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

END OF SECTION 16215

SECTION 16264
STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, Division 1 – General Requirements, and other applicable Specification Sections in the Project Manual apply to the work specified in this Section.

1.02 SUMMARY

A. Scope: Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a static uninterruptible power supply (UPS) as required for the complete performance of the work and as shown on the Drawings and as herein specified.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, a continuous duty, three-phase, solid state, on-line double conversion static UPS.

1. The UPS shall utilize a rack-mounted N+1 redundant, scalable array architecture. The system power train shall be comprised of 10 kVA/10 kW power modules and shall be capable of being configured for N+X redundant operation at the rated system load. In systems operating at a load where the system is N+1 or greater, the UPS shall facilitate the replacement of power modules while the system remains in normal operation, without the requirement to transfer to bypass (trained personnel hot swappable).
2. Each 10 kVA/10 kW power module shall contain a fully rated input rectifier/boost converter hereafter referred to as the input converter, a fully rated output inverter, and battery charging circuit. The system shall also be comprised of a trained personnel hot swappable continuous duty bypass static switch module, trained personnel hot swappable battery modules, redundant control modules, redundant logic power supplies, and LCD interface/display. All of the above system components shall be housed in standard 600 mm wide by 1070 mm deep by 2,000 mm high enclosures.
3. In addition, this Section describes the performance, functionality, and design of the power distribution unit, hereafter referred to as the PDU, and the battery system.
4. The UPS and associated equipment shall operate in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for mission critical, electronic equipment load.
5. All programming and miscellaneous components for a fully operational system as described in this Section shall be available as part of the UPS.

1.03 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE): ANSI/IEEE 519, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters" (copyrighted by IEEE, ANSI approved).

C. International Organization for Standardization (ISO):

1. ISO 9001, "Quality Management Systems - Requirements."
2. ISO 14001, "Environmental Management Systems - Requirements With Guidance for Use."

D. Underwriters Laboratories, Inc. (UL):

1. UL 1778 second Edition, "Standard for Uninterruptible Power Supply Equipment" (copyrighted by UL, ANSI approved).
2. UL 60950-1, "Standard for Information Technology Equipment."

E. International Electrotechnical Commission (IEC)

1. IEC 61000-4-2, "Electromagnetic Compatibility - Testing and Measurement Techniques; Electrostatic Discharge Immunity Test."
2. IEC 61000-4-3, "Electromagnetic Compatibility - Testing and Measurement Techniques; Radiated, Radio Frequency, Electromagnetic Field Immunity Test."
3. IEC 61000-4-4, "Electromagnetic Compatibility - Testing and Measurement Techniques; Electrical Fast Transient/Burst Immunity Test."
4. IEC 61000-4-5, "Electromagnetic Compatibility - Testing and Measurement Techniques; Surge Immunity Test."
5. IEC 62040-2, "Uninterruptible Power Systems - Electromagnetic Compatibility (EMC) Requirements,"
6. IEC 62040-3, "Uninterruptible Power Systems - Method of Specifying the Performance and Test Requirements."

F. CSA:

1. C22.2 no. 107.1-M95, "General Use Power Supplies."
2. 60950-1, "Information Technology Equipment - Safety - Part 1: General Requirements."

G. EMC:

1. FCC part 15 Class A.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. The UPS shall be sized for 20 kW load.
2. The UPS battery shall be sized for 20 kW at a power factor of 0.8 for 24 hours.

B. System Characteristics:

1. System Capacity: The system shall be rated for full kW output in the following frame sizes:
   a. 100 kVA/kW, can be configured with up to ten, 10 kW power modules for 100 kW or 90 kW N+1.

2. Input: The system input shall be configurable as either single or dual mains derived from a three phase wye source. Standard cable entry shall be through the top. Bottom cable entry shall also be facilitated. Depending on the specific configuration, the use of the optional side car may be required.
   a. AC Input Nominal Voltage: 480 Y/277 V three-phase, 4-wires plus ground, 60 Hz.
   b. AC Input Voltage Window:
   c. ±15 percent for full performance.
      i) Short Circuit Withstand Rating: 30,000 symmetrical amperes.
   d. Maximum Frequency Range: 40 to 70 hertz.
   e. Input Power Factor:
      i) Greater than 0.99 with load at 100 percent.
      ii) Greater than 0.98 with loads above 50 percent.
      iii) Greater than 0.95 with loads above 25 percent.
   f. Input Current Distortion With No Additional Filters: Less than 5 percent at full load.
   g. Soft-Start: Shall be linear from 0 percent to 100 percent input current and shall not exhibit inrush. This shall take place over a selectable 1 second to 60 second time period with a factory default of 10 seconds.

3. UPS Output:
   a. AC Output Nominal Output: 480 Y/277 V, 4-wires plus ground, 60 Hz.
   b. AC Output Voltage Distortion: Less than 2 percent at 100 percent linear load, less than 6.5 percent for non-linear load as defined by IEC/EN 62040-3.
   c. AC Output Voltage Regulation: ±1 percent for 100 percent linear or non-linear load.
   d. Voltage Transient Response: ±5 percent maximum RMS change in a half cycle at load step 0 percent to 100 percent or 100 percent to 0 percent.
   e. Voltage Transient Recovery: Within less than 50 milliseconds.
   f. Output Voltage Harmonic Distortion: Less than 2 percent THD maximum and 1 percent single harmonic for a 100 percent linear load.
   g. Overload Capabilities:
      i) Normal Operation:
         a) 150 percent for 30 seconds before transfer to bypass.
      i) Battery Operation: 150 percent for 30 seconds.
      ii) Bypass Operation:
         a) 125 percent continuous at 208 volts.
         b) 1,000 percent for 100 milliseconds.
   h. System Efficiency:
      i) Normal operation greater than 92.5 percent at 35 percent to 100 percent load.
      ii) Battery operation greater than 92.5 percent at 35 percent to 100 percent load.
   i. Output Power Factor Rating: 0.5 leading to 0.5 lagging without any derating.

1.05 SUBMITTALS

A. General: Submittals shall be made in accordance with the requirements of the General Conditions.

B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, the following:

1. As bid system bill of materials.
2. Product catalog sheets or equipment brochures.
3. Product guide specifications.

C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data, including, but not limited to, the following:

1. Installation information, including, but not limited to, weights and dimensions.
2. Information about terminal locations for power and control connections.
3. Drawings for requested optional accessories.

D. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.

1. Submit system single-line operation diagram.

E. Operation and Maintenance Data: Submit operation and maintenance data to include in operation and maintenance manuals specified in Division 1 – General Requirements, including, but not limited to, safe and correct operation of UPS functions.

1. Submit an installation manual, which shall include, but shall not be limited to, instructions for storage, handling, examination, preparation, installation, and start-up of UPS.
2. Submit an operation and maintenance manual, which shall include, but shall not be limited to, operating instructions.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of solid state UPS of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.
   a. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.
2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing solid state UPS similar in type and scope to that required for this Project.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

1. Work shall also be designed in accordance with the following:
   a. UL 1778 second edition
   b. UL 60950-1
2. Where applicable, the UPS shall also be designed in accordance with publications from the following organizations and committees:
   a. National Fire Protection Association (NFPA).
   b. National Electrical Manufacturers Association (NEMA).
   c. Occupational Safety and Health Administration (OSHA).
   d. Institute of Electrical and Electronics Engineers, Inc. (IEEE); ANSI/IEEE 519.
   e. ISO 9001
   f. ISO 14001
   g. FCC

C. Pre-Installation Conference: Conduct pre-installation conference in accordance with Section 01200- Project Meetings. Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Architect/Engineer.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.08 PROJECT CONDITIONS

A. Environmental Requirements: Do not install the UPS until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1. Environmental:
   a. Storage Ambient Temperature: 5 °F (-15 °C) to 104 °F (40 °C).
   b. Operating Ambient Temperature: 32 °F (0 °C) to 104 °F (40 °C) (77 °F (25 °C) shall be ideal for most battery types).
   c. Relative Humidity: 0 percent to 95 percent non-condensing.

d. Altitude: Maximum installation with no derating of the UPS output shall be 3280 feet (1,000 m) above sea level. The UPS capacity shall be derated for altitude as follows:
   i) 4,921 feet (1,500 m), 95 percent load.
   ii) 6,562 feet (2,000 m), 91 percent load.
   iii) 8,202 feet (2,500 m), 86 percent load.
   iv) 9,843 feet (3,000 m), 82 percent load.

e. Audible Noise (As Measured 3 Feet From Surface):
   i) 60 dBA at 70 percent load.
   ii) 67 dBA at 100 percent load.

1.09 WARRANTY

A. General: See Section 01700 – Closeout Procedures.

B. Special Warranty: The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This special warranty shall extend the one year period of limitations contained in the General Conditions. The special warranty shall be countersigned by the Installer and the manufacturer.

1. The UPS shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of installation or acceptance by the Owner or 18 months from date of shipment from the manufacturer, whichever occurs first.

C. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.10 MAINTENANCE

A. A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available from the manufacturer. Contract work shall be performed by factory-trained service personnel.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Product specified SG Series as manufactured by GE, Powerware as manufactured by Eaton, or "APC Symmetra PX 100 kW" as manufactured by APC by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

2.02 MODES OF OPERATION

A. Normal: The Input converter and output inverter shall operate in an on-line manner to continuously regulate power to the critical load. The input and output converters shall be capable

of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.

B. Battery: Upon failure of the AC input source, the critical load shall continue being supplied by the output inverter, which shall derive its power from the battery system. There shall be no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation.

C. Recharge: Upon restoration of utility power to the UPS input, the input converter and output inverter shall simultaneously recharge the battery and provide regulated power to the critical load.

D. Static Bypass: The static bypass shall be used to provide controller transfer of critical load from the inverter output to the bypass source. This transfer, along with its retransfer, shall take place with no power interruption to the critical load. In the event of an emergency, this transfer shall be an automatic function.

E. Maintenance Bypass: The system shall be equipped with an external make-before-break maintenance bypass cabinet (MBC) to electrically isolate the UPS during routine maintenance and service of the UPS. The MBC shall allow for the completely electrical isolation of the UPS.

2.03 INPUT CONVERTER

A. General: The Input converters of the system shall be housed within the removable power modules, and shall constantly control the power imported from the mains input of the system, to provide the necessary UPS power for precise regulation of the DC bus voltage, battery charging, and main inverter regulated output power. These power modules shall be connected in parallel within the UPS frame.

B. Input Current Total Harmonic Distortion: The input current THDI shall be held to less than 5 percent at full system load, while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This shall be true while supporting both a linear or non-linear load. This shall be accomplished without the requirement for additional filters, magnetic devices, or other components.

C. Soft-Start Operation: As a standard feature, the UPS shall contain a user-adjustable soft-start, capable of limiting the input current from 0 percent to 100 percent of the nominal input over a default 10 second period, when returning to the AC utility source from battery operation. The change in current over the change in time shall take place in a linear manner throughout the entire operation.

D. Magnetization Inrush Current: The UPS shall exhibit zero inrush current as a standard product. If provided with an optional isolation transformer, inrush should be limited to 11 times the nominal input current of the transformer.

E. Input Current Limit:

1. The Input converter shall control and limit the input current draw from utility to 150 percent of the UPS output. During conditions where input current limit is active, the UPS shall be able to support 100 percent load, charge batteries at 10 percent of the UPS output rating, and provide voltage regulation with mains deviation +15/-5 percent.

2. In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100 percent of UPS capacity, input current shall not exceed 125 percent of UPS output current, while providing full battery recharge power and importing necessary power to account for system losses.

F. Redundancy: The UPS shall be capable of being configured with redundant Input converters, each with semiconductor fusing, and logic-controlled contactors to isolate a failed module from the input bus.

G. Back-Feed Protection: The above mentioned logic-controlled contactor shall also provide the back-feed protection required by UL 1778, CSA 22.2, and IEC/EN Standards.

H. Charging:

1. The battery charging shall keep the DC bus float voltage of ±218 volts, ±1 percent.
2. The battery charging circuit shall contain a temperature compensation circuit, which shall regulate the battery charging to optimize battery life.
3. The battery charging circuit shall remain active when in static bypass and in normal operation.
4. Maximum charging power: 10% of output power rating or a maximum charge current of 0.25 CA.

2.04 OUTPUT INVERTER

A. General: The UPS output inverter shall constantly develop the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT driven power converters. In both normal operation and battery operation, the output inverters shall create an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages shall not affect the amplitude or sinusoidal nature of the output voltage sine wave of the inverters.

B. Overload Capability: Steady-state overload conditions, of up to 150 percent of system capacity shall be sustained by the inverter for 30 seconds in normal and battery operation. Should overloads persist past the outlined time limitation, the critical load shall be switched to the automatic static bypass output of the UPS.

C. Output Contactor: The output inverter shall be provided with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter shall be isolated from the critical bus.

D. Battery Protection: The inverter shall be provided with monitoring and control circuits to limit the level of discharge on the battery system.

E. Redundancy: The UPS shall be capable of being configured with redundant output inverters, each with semiconductor fusing, and logic-controlled contactors to remove a failed component from the input, DC, and output critical bus.

2.05 STATIC BYPASS

A. General: As part of the UPS, a system static bypass cabinet shall be provided. The system static bypass shall provide no break transfer of the critical load from the inverter output to the static bypass input source during times where maintenance is required, or the inverter cannot support the critical bus. Such times may be due to prolonged or severe overloads, or UPS failure. The UPS and static bypass switch shall constantly monitor the auxiliary contacts of their respective circuit breakers, as well as the bypass source voltage, and inhibit potentially unsuccessful transfers to static bypass from taking place.

B. Design: The design of the static switch power path shall consist of silicon-controlled rectifiers (SCR) with a continuous duty rating of 125 percent of the UPS output rating.

C. Automatic Transfers: An automatic transfer of load to static bypass shall take place whenever the load on the critical bus exceeds the overload rating of the UPS. Automatic transfers of the critical load from static bypass back to normal operation shall take place when the overload condition is removed from the critical output bus of the system. Automatic transfers of load to static bypass shall also take place if for any reason the UPS cannot support the critical bus.

D. Manual Transfers: Manually initiated transfers to and from static bypass shall be initiated through the UPS display interface.

E. Overloads: The static bypass shall be capable of handling overloads equal to or less than 125 percent of the rated system output continuously. For instantaneous overloads caused by inrush current from magnetic devices, or short circuit conditions, the static bypass shall be capable of sustaining overloads of 1,000 percent of system capacity for periods of up to 100 milliseconds.

F. Modular: The static bypass switch shall be of a modular design.

G. System Protection: As a requirement of UL 1778, back-feed protection in the static bypass circuit shall also be incorporated in the system design. To achieve back-feed protection, a mechanical contactor in series with the bypass SCR(s) shall be controlled by the UPS/static switch, to open immediately upon sensing a condition where back-feeding of the static switch by any source connected to the critical output bus of the system is occurring. One such condition could be a result of a shorted SCR.

2.06 DISPLAY AND CONTROLS

A. Control Logic: The UPS shall be controlled by two fully redundant, trained personnel hot-swappable intelligence modules (IM). These modules shall have separate, optically isolated, communication paths to the power and static switch modules. Logic power for the control modules shall be derived from redundant power supplies, each having a separate AC and DC input and output. The communication of the control modules shall be of controller area network (CAN Bus).

B. Display unit: A microprocessor-controlled display unit shall be located on a hinged door in front of the system. The display shall consist of an alphanumeric display with backlight, four LEDs for quick status overview, and a keypad consisting of pushbutton switches.

C. Metered Data: The following data shall be available on the alphanumeric display:

1. Year, month, day, hour, minute, second of occurring events.
2. Source input voltage.
3. Output AC voltage.
4. Output AC current.
5. Input frequency.
6. Battery voltage.

D. Event Log: The display unit shall allow trained personnel to display a time and date stamped log.

E. Alarms: The display unit shall allow the Owner to display a log of active alarms. The following minimum set of alarm conditions shall be available:

1. Input frequency outside configured range.
2. AC adequate for UPS but not for bypass.
3. Low/no AC input, startup on battery.
4. Intelligence module inserted.
5. Intelligence module removed.
6. Redundant intelligence module inserted.
7. Redundant intelligence module removed.
8. Number of batteries changed since last on.
9. Number of power modules changed since last on.
10. Number of batteries increased.
11. Number of batteries decreased.
12. Number of power modules increased.
13. Number of power modules decreased.
14. Number of external battery cabinets increased.
15. Number of external battery cabinets decreased.
16. Redundancy restored.
17. Need battery replacement.
18. The redundant intelligence module is in control.
19. UPS fault.
20. On battery.
21. Shutdown or unable to transfer to battery due to overload.
22. Load shutdown from bypass. input frequency, volts outside limits.
23. Fault, internal temperature exceeded system normal limits.
24. Input circuit breaker open.

25. System level fan failed.
26. Bad battery module.
27. Bad power module.
28. Intelligence module installed and failed.
29. Redundant intelligence module installed and failed.
30. Redundancy lost.
31. Redundancy below alarm threshold.
32. Runtime below alarm threshold.
33. Load above alarm threshold.
34. Load no longer above alarm threshold.
35. Minimum runtime restored.
36. Bypass not in range (either frequency or voltage).
37. Back-feed contactor stuck in OFF position.
38. Back-feed contactor stuck in ON position.
39. UPS in bypass due to internal fault.
40. UPS in bypass due to overload.
41. System in forced bypass.
42. Fault, bypass relay malfunction.
43. High DC warning.
44. High DC shutdown.
45. Low battery shutdown.
46. Low battery warning.

F. Controls: The following controls or programming functions shall be accomplished by the use of the display unit. Pushbutton membrane switches shall facilitate these operations:

1. Silence audible alarm.
2. Display or set the date and time.
3. Enable or disable the automatic restart feature.
4. Transfer critical load to and from static bypass.
5. Test battery condition on demand.
6. Set intervals for automatic battery tests.
7. Adjust set points for different alarms.
8. Program the parameters for remote shutdown.

G. Potential Free (Dry) Contacts: The following potential free contacts shall be available on an optional relay interface board:

1. Normal operation.
2. Battery operation.
3. Bypass operation.
4. Common fault.
5. Low battery.
6. UPS off.

H. Communication Interface Board: A communication interface board shall provide the following communication ports which shall be able to be used simultaneously:

1. RS232 serial port #1.

2.07 BATTERY

A. The UPS battery shall be of a modular construction made up of trained personnel hot swappable, fused, battery modules. Each battery module shall be monitored for voltage and temperature for use by the UPS battery diagnostic and temperature compensated charger circuitry.

B. The battery jars housed within each removable battery module shall be of the valve regulated lead acid (VRLA) type.

C. The UPS shall incorporate a battery management system to continuously monitor the health of each removable battery module. This system shall notify the user in the event a failed or weak battery module is found.

2.08 ACCESSORIES

A. Power Distribution Unit: For the purpose of providing power distribution to the protected load, a range of power distribution modules and accessories shall be available.

B. Battery Solutions: For purposes of providing UPS back-up power, battery enclosures shall be available. For ease of maintenance the battery enclosures shall house draw-out battery cartridges. Battery cartridges shall interlock in place within the battery enclosure to ensure proper contact. This will ensure that the customer will not inadvertently withdraw the battery pack in an unsafe manner. The battery solution shall be housed in a standard 24 inch (610 mm) wide, 36 inch (914 mm) deep, 42 U high enclosure. Up to four battery enclosures may be added for increased battery runtime.

C. Software and Connectivity:

1. Network Adaptor: The ethernet web/SNMP adaptor shall allow one or more network management systems (NMS) to monitor and manage the UPS in TCP/IP network environments. The management information base (MIB) shall be provided in DOS and UNIX "tar" formats. The SNMP interface adaptor shall be connected to the UPS via the Network Management Cart Ethernet Port.

2. Unattended Shutdown:
   a. The UPS, in conjunction with a network interface card, shall be capable of gracefully shutting down one or more operating systems.
   b. The UPS shall also be capable of using an RS232 port to communicate by means of serial communication to gracefully shut down one or more operating systems during an on battery situation.

D. Remote Ups Monitoring: The following methods of remote UPS monitoring shall be available:

1. Web Monitoring: Remote monitoring shall be available via a web browser such as Internet Explorer.
2. RS232 Monitoring: Remote UPS monitoring shall be possible via either RS232 or contact closure signals from the UPS.
3. Simple Network Management Protocol (SNMP): Remote UPS monitoring shall be possible through a standard MIB II compliant platform.

E. Software Compatibility: The UPS manufacturer shall have available software to support graceful shutdown for the following systems:

1. Microsoft Windows 95/98/XP.
2. Microsoft Windows NT 4.0 SP6/2000.
3. OS/2.
4. Netware 3.2 – 5.1.
5. MAC OS 9.04, 9.22, 10.
6. Digital Unix/True 64.
7. SGI 6.0-6.5.
8. SCO UNIX.
9. SVR4 2.3, 2.41.
10. SCO Unix Ware 7.0 - 7.11.
11. SUN Solaris 2.6-2.8.
12. SUN OS 4.13, 4.14.
13. IBM AIX 4.3x-4.33g, 5.1.
14. HP-UX 9.x-11.i.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.02 INSTALLATION

A. General: Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

B. Factory-Assisted Start-Up: If a factory-assisted UPS start-up is requested, factory-trained service personnel shall perform the following inspections, test procedures, and on-site training:

1. Visual Inspection:
   a. Inspect equipment for signs of damage.
   b. Verify installation per manufacturer's instructions.
   c. Inspect cabinets for foreign objects.
   d. Inspect battery units.
   e. Inspect power modules.
2. Mechanical Inspection:
   a. Check UPS and external maintenance bypass cabinet internal control wiring connections.
   b. Check UPS and external maintenance bypass cabinet internal power wiring connections.
   c. Check UPS and external maintenance bypass cabinet terminal screws, nuts, and/or spade lugs for tightness.
3. Electrical Inspection:
   a. Verify correct input and bypass voltage.
   b. Verify correct phase rotation of mains connections.
   c. Verify correct UPS control wiring and terminations.
   d. Verify voltage of battery modules.
   e. Verify neutral and ground conductors are properly landed.
   f. Inspect external maintenance bypass switch for proper terminations and phasing.
4. Site Testing:
   a. Ensure proper system start-up.
   b. Verify proper firmware control functions.
   c. Verify proper firmware bypass operation.
   d. Verify proper maintenance bypass switch operation.
   e. Verify system set points.
   f. Verify proper inverter operation and regulation circuits.
   g. Simulate utility power failure.
   h. Verify proper charger operation.
   i. Document, sign, and date test results.
5. On-Site Operational Training: During the factory-assisted start-up, operational training for site personnel shall include, but shall not be limited to, key pad operation, LED indicators, start-up and shutdown procedures, maintenance bypass and AC disconnect operation, and alarm information.

3.03 FIELD QUALITY CONTROL

A. General: See Section 01450- Special Inspection and Testing.

B. Manufacturer Field Service:

1. Worldwide Service: The UPS manufacturer shall have a worldwide service organization available, consisting of factory-trained field service personnel to perform start-up, preventative maintenance, and service of the UPS system and power equipment. The service organization shall offer 24 hours a day, 7 days a week, 365 days a year service support.

2. Replacement Parts: Parts shall be available through the worldwide service organization 24 hours a day, 7 days a week, 365 days a year. The worldwide service organization shall be capable of shipping parts within four working hours or on the next available flight, so that the parts may be delivered to the Owner within 24 hours.

3.04 DEMONSTRATION

A. General: Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.

1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.

3. Review data in operation and maintenance manuals with the Owner's personnel.

4. Schedule training with the Owner, through the Architect/Engineer, with at least seven day's advanced notice.

B. UPS Training Workshop: A UPS training workshop shall be available from the UPS manufacturer. The training workshop shall include, but shall not be limited to, a combination of lecture and practical instruction with hands-on laboratory sessions. The training workshop shall include, but shall not be limited to, instruction about safety procedures, UPS operational theory, sub-assembly identification and operation, system controls, adjustments, preventative maintenance, and troubleshooting.

3.05 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, which shall ensure that the solid state UPS shall be without damage at time of Substantial Completion.

END OF SECTION 16264

SECTION 16361
LOW VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of metal enclosed low voltage power switchgear, rated 600 volts. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Related Work specified elsewhere:

1. Section 16000 - Electrical Power and Systems.
2. Section 16050 - Basic Electrical Material and Methods.
3. Section 16175 - Instrument Transformers, Meters, Switches and Accessories.
4. Section 16450 - Grounding.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Electrical Elementary Diagrams and Internal Connection Diagrams.
2. Manufacturer's data indicating interrupting, withstand and continuous current ratings of all equipment components.
3. Arrangement and layout drawings of the switchgear enclosures depicting equipment and bus bar arrangement, size and number of busbars per phase, neutral and ground nameplate legends and overall dimension including areas of permissible cable entries. A list of material and components shall accompany the layout drawings.
4. Results of factory tests and field breaker setting tests as specified in paragraph 16361-3.02.
5. Time current curves on 14-inch log-log transparency paper for all protective devices.
6. Mimic bus layout.
7. Catalog data on all electrical devices and components mounted on or within the switches.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI, American National Standards Institute.
2. NEMA, National Electrical Manufacturers Association.
3. UL, Underwriters laboratories.

1.04 QUALITY STANDARDS

A. The switchgear covered by these Specifications shall be designed, tested and assembled in accordance with the following standards.

1. ANSI C37.20, Switchgear assemblies including metal enclosed busbars.
2. ANSI C57.13, Requirements for Instrument Transformers.
3. NEMA SG-5, Metal Enclosed Switchgear Assembly.
4. UL 1558, Switchgear Design.

B. Manufacturers offering products that comply with these Specifications include:

1. Square-D Company.
2. General Electric Company
3. Cutler-Hammer Electric Corporation.
4. Or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

1.06 DELIVERY, STORAGE AND HANDLING

A. Arrange shipping splits as required for installation. Individually wrap each section and mount on shipping skids.

B. Store in a clean and dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect equipment from dirt, water, construction debris and traffic.

C. Handle in accordance with NEMA PB-2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish switchgear rated 600 volt, 3-phase, 3-wire or 4-wire, 60 Hertz. Brace buses and bus structures for the rms symmetrical amperes, short circuit as indicated on the Drawings.

B. Coordinate all primary parts of the metal enclosed equipment, including circuit breakers, fuses, buses, connections and insulators to withstand mechanical and thermal stresses for use on the proposed system.

C. Furnish steel channel sills with suitable drilled holes for mounting, aligning and bolting switchgear in place. Method of mounting as indicated. Provide size recommended by switchgear manufacturer and acceptable to Engineer. Paint completed sills with two coats of aluminum paint or other acceptable corrosion-resistant finish before setting in place.

D. If switchgear equipment pads are located on concrete floor slabs, furnish painted steel channel mounting sills and anchor bolts, including location instruction for setting in place during construction of the concrete equipment pads.

2.02 ENCLOSURE

A. Switchgear shall be factory assembled and metal enclosed. Each unit shall consist of a stationary structure assembly and one or more air circuit breaker units, disconnecting devices, and other specified equipment. Switchgear shall be suitable for 600V, 3 phase maximum service. Each unit shall be provided with a breaker hoist for removing the breaker for maintenance.

B. Switchgear shall be completely self-supporting structure of required number of vertical sections bolted together to form one metal enclosed switchgear 90 inches (2,300 mm) high. Sides, top and rear covers are code gauge steel, bolted to switchgear structure. Frame structure members die-formed 11 gauge steel bolted together and reinforced at external corners, with rugged gussets internal and external to structure members. Switchgear frame shall be suitable for use as floor sills in indoor installations. Switchgear assemblies shall conform to NEMA Standard SG-5. The switchgear shall be furnished with an indoor NEMA 1 enclosure.

C. Outdoor switchgear shall be fully weatherproof, housed in a factory assembled outdoor enclosure, have lifting plates at the base of the structure, hinged aisle doors with rubber gaskets and pad locking provisions, asphalt base undercoating on the exterior bottom, interior lights, space heater per vertical section, outlets and light switch and space heater switch. Enclosure shall include front aisle space running the full length of the equipment, sloping roof, rear bolted hinged doors, breaker lifting device, wire meshed louvers and rodent guards.

2.03 SWITCHGEAR CONSTRUCTION

A. Provide switchgear with incoming line main devices in individually mounted construction, and feeder devices in group-mounted construction. Incoming line main devices side or rear accessible through bolted-on covers. Group mounted devices, front accessible per NEMA standards, furnished with wiring gutters on front of distribution vertical sections of switchgear. Provide gutters with code gauge steel formed covers bolted to structure frame. Cover unused device space with blank code gauge steel formed covers.

B. Construct metal-enclosed switchgear structure from formed sections of specially smoothed and leveled steel, not less than 11 gage, welded together and reinforced, where necessary, with formed steel members. Resulting structure shall be totally enclosed, self-supporting free-standing.

C. Make provision for conduit and cable entrance from top or bottom as indicated.

D. Enclose bus compartments and the instrument and control power transformer compartments completely with sheet steel and separate from each other by means of tightly fitted steel barriers.

E. Where space is indicated, provide compartment complete with buses, bus supports, insulators, primary and secondary disconnects, rails and other accessories to require only insertion of breaker removable element. Provide insulating barriers in switchgear units to cover all live parts.

F. Each breaker compartment shall be equipped with primary and secondary contacts, rails, and stationary levering mechanism. A rear hinged cover shall be provided for each cable compartment, and a front-hinged door shall be provided for each breaker and metering component.

G. Structures shall be provided with horizontal and vertical barriers to separate different voltage classes, buses and incoming cables.

2.04 BUS BARS

A. Main bus and riser bus shall be tin plated copper supported with high impact, non-tracking insulating material, and braced to withstand mechanical forces exerted during short circuit conditions, to rating of protective devices as indicated.

B. Contact surfaces of main bus joints and all tap connections shall be silver-plated.

C. Current density of bus not to exceed 750 amperes per square inch cross-section. If main circuit protective device is provided, continuous current rating of bus shall be equivalent to frame size rating of that device.

D. Furnish a ground bus and secure to each vertical section structure. Extend ground bus for entire length of switchgear. Ground bus shall have momentary rating equal to highest circuit breaker momentary rating in the assembly and provided with one clamp type terminal at each end for No. 4/0 bare copper ground. Ground bus shall be copper.

E. Furnish a neutral bus for 3- phase, 4-wire system. Neutral bus shall have the same ampacity as the main bus. Neutral bus shall be copper.

2.05 CIRCUIT BREAKERS

A. Breaker element shall consist of a three-pole manually operated electrically and mechanically trip-free power circuit breaker with solid state, overcurrent trip device, arc quenchers, manual stored energy closing mechanism, mechanical pushbutton trip and position indicator. Breaker element shall be suitable for mounting on the drawout mechanism in the circuit breaker compartment. Main and feeder circuit breakers shall have a minimum interrupting current of 100,000 (symmetrical) at 480 volt.

B. Disconnecting devices shall be the self-aligning type with the disconnecting fingers mounted on the breaker. The drawout mechanism shall, rigidly hold the circuit breaker in the fully connected, test, and fully disconnected positions. Interlocks shall be provided to prevent moving the circuit breaker from fully connected, test, or fully disconnected positions unless the breaker is open. Interlocks shall also prevent closing the breaks between any of these, positions.

C. The drawout mechanism shall be designed so that the breaker can be racked to any position without opening the door. A hasp on the breaker escutcheon shall be provided that can receive three padlocks when the breaker is in the open position.

D. Unless otherwise specified, breakers shall be equipped with one normally open and one normal closed auxiliary switch. Switches shall be rated 10 amperes, 120 volts AC wired to terminal blocks.

E. Solid state tripping devices shall consist of current sensor logic assembly, magnetic latch release, and required interconnecting wiring. Tripping devices shall be automatic and self-contained within the breaker frame, and shall not require external relaying or power supplies. Tripping device for feeder breakers shall include current indicating function for each phase, utilizing a digital, LCD display with a clear plastic cover.

F. Tripping device shall be provided with manually resettable fault indicators. As a minimum, fault indicators shall provide indication of tripping caused by overload, short circuit or ground fault.

G. Tripping functions shall be field adjustable and shall provide, as specified, the following tripping characteristics:

1. Overload Tripping:
   a. Adjustable ampere setting.
   b. Adjustable long-time delay.
2. Short Circuit Tripping:
   a. Adjustable short-time pick-up.
   b. Adjustable short-time delay.
   c. Adjustable instantaneous pick-up.
3. Ground Fault Tripping:
   a. Adjustable ground fault pick-up.
   b. Adjustable ground fault delay.
4. Ground fault protection for main circuit breakers shall be accomplished by hard-wired relay 51G, and shall not be included in the solid state tripping device.

H. Ground fault relays for double ended, multiple grounded configurations shall be fully responsive to ground fault currents returning to either source, and shall not respond to line to neutral currents.

I. Provide one 51G ground overcurrent relay for transformer secondary overcurrent protection.

J. Provide 1 current transformers 1,200/5 on the transformer secondary neutral.

2.06 WIRING

A. Switchgear shall be completely wired at factory. All secondary shall be made with standard switchgear wire and cable, single conductor 900 C copper wire UL listed for panel wiring, minimum size No. 14 AWG.

B. Provide acceptable terminal blocks with marking strips for all secondary circuits leaving metal enclosed structure and for interconnecting separate compartments.

C. Enclose all wiring between stationary units in metal raceway or compartments with removable covers.

D. Where wiring connections are made to equipment mounted on hinged doors, provide terminal blocks or wire cleats for all secondary and control circuits leaving metal enclosed structure and for connecting separate compartments. Conductor markers shall be as specified in Section 16120.

2.07 CONTROL POWER TRANSFORMERS

A. Control power transformers shall be rated 480-120 volts, single-phase, 2-wire, 60 Hertz, with kva rating as required by switchgear, but not less than 1.0 kva. Mount current limiting primary fuses for control power transformer on disconnecting or draw out fuse mounts. Provide secondary fuses.

2.08 INSTRUMENTS, RELAYS AND CONTROL EQUIPMENT

A. All instruments and relays shall be provided with semi-flush mounted cases and dust tight. All relays, instruments and meters shall be accurately calibrated for satisfactory operation after installation. Instrument relays shall conform to NEMA Std. 11-2.

B. Protective devices shall be adjusted to the settings specified in Section 16100, prior to energizing switchgear.

C. Fuse blocks and fuses shall be provided as required, for the protection of the instruments.

D. Suitable rated current and potential test blocks shall be furnished with matching plugs, for connecting external instruments installed as indicated. Test blocks shall be 6- or 8-point, suitably marked and connected for inserting both current and potential test leads.

E. Indicating instruments and control switches shall be in accordance with Section 16175, Instrument Transformers, Meters, Switches and Accessories.

2.09 NAMEPLATES

A. Provide nameplates for switchgear main and feeder breakers engraved on laminated plastic with black lettering on white background. Nameplates shall comply with Section 16050-2.11.

2.10 PAINTING

A. All steel surfaces of switchgear assembly shall be chemically cleaned and finished with ANSl No. 61 gray enamel over rust-resistant undercoat.

B. All meters, instruments and relays shall be provided with dull black finish.

2.11 SPARE PARTS

A. Provide spare parts as recommended by manufacturer.

B. Package spare equipment in suitable containers bearing labels clearly indicating contents and in what equipment used.

C. Deliver spare parts at same time as equipment. Properly store and safeguard such spare parts until completion of work, at which time deliver as directed by the Engineer.

2.12 MIMIC BUS

A. Provide a laminated, plastic mimic bus illustrating single line diagram identifying breaker numbers and load supplied by the breaker. Permanently mount the mimic bus with stainless steel screws.

2.13 FACTORY TESTS

A. After assembly, switchgear shall be tested for operation at the specified voltage and current ratings. The main circuits shall be given a dielectric test of 2,200V for 1 minute between the live parts and ground, and between opposite polarities. The wiring and control circuits shall be given a dielectric test of 1500V for 1 minute between the live parts and ground.

B. Instrument transformers shall have ratio and phase angle tests made in conformance with ANSI C57.13.

C. Three copies of test results shall be submitted to the Engineer.

2.14 NETWORKING

A. Switchgear shall be ModBus compatible. Connect to PLC, pump monitoring panels, and local control panels.

2.15 SURGE PROTECTIVE DEVICE

A. A surge protective device shall be furnished and installed with the switchgear. Refer to SECTION 16445 – SURGE PROTECTIVE DEVICE FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Properly set and level channel sills.

B. Furnish complete, clear; and concise instructions for installation, operation, and maintenance of the equipment

3.02 FIELD TESTS

A. The protective devices shall be adjusted to the settings specified in the coordination study prior to energizing the switchgear.

B. Each switchgear breaker shall be tested in accordance with Section 16999.

END OF SECTION 16361

SECTION 16430
PROTECTIVE RELAYING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of all protective relaying. All protective relaying shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Catalog cuts: Full-size time-current curves on vellum similar to the log graph as produced by K&E and instruction manuals shall be submitted to the Engineer for approval within 90 days after receipt of Notice to Proceed.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. ANSI C37.9, Relays.
2. ANSI C37.91, IEEE Guide for Protective Relay Application to Power Transformers.
3. ANSI C37.92, Guide for Induction Motor Protection.
4. ANSI C37.95, Guide for Protective Relaying of Utility-Consumer Interconnections.

1.04 RELAY SETTINGS

A. The Contractor shall furnish the Engineer with relay settings and exact relay model number not later than 120 days after receipt of the following information from the manufacturers:

1. All motor data sheets for 125 HP and larger.
2. All motor heating curves for motors 125 horsepower and larger.
3. All switchgear and switchboard submittal information.

4. Impedance and ratio submittals on medium and high voltage transformers.
5. Burden, accuracy class and ratio data submittals on all instrument transformers.
6. All protective relay submittal information.

B. The protective relay settings shall be provided to the Engineer not later than 120 days prior to the beginning of compliance testing. Actual time current, time voltage and time frequency configurations shall be determined by the coordination study results. Protective relays required to conform to this study recommendations shall be provided, at no additional cost to the City.

PART 2 - PRODUCTS

2.01 GENERAL

A. Protective relays shall be semi-flush mounting, back connected and have dust-tight cases. Protective relays except timing relays shall have removable chassis construction, which provides for removal of the relay without disconnecting leads or removing the case from the panel. Means shall be provided to automatically short-circuit associated current transformer secondaries when the relay is removed from its case. External circuits which are normally operated open shall remain open during the time the relay is being removed or replaced and while the relay is out of the case, even though the relay contacts may close. Likewise, external circuits, which are normally operated closed shall remain closed. Provisions shall be made to permit inserting test plugs in series with all current transformer secondaries and in parallel with all potential transformer secondaries. Test plugs shall be furnished, each with sufficient points to test all relays. Relay front cover shall be removable from the front without the use of tools. Where available as a standard option, targets and seal-in contacts shall be provided. Targets shall be resettable from the front without removing the cover. The relays, unless specified otherwise, shall be for operation on a 24 volt DC control bus. The relays shall have silver-to-silver non-bouncing contacts rated 30 amperes current closing at 24 volts. The relays Co be provided shall be as specified. All relays shallbe the product of a single manufacturer. Relays are listed in terms of functions and IEEE device number for that function in parentheses.

2.02 OVERCURRENT RELAYS

A. Time Current and Instantaneous Overcurrent Relay (50/51): Used to protect electrical equipment, bus and cables from phase-to-phase and three-phase faults, very inverse time characteristics, 11-12 amperes current range, 60 Hz, with current coil rated 5 amperes continuous, 6-150 amperes instantaneous unit, 0.2/2 ampere seal-in unit with target. Cutler-Hammer Type CO-, General Electric Type IAC, or equal.

B. Time overcurrent (51G): Used to protect generator and transformer from phase-to-ground or phase-to-phase faults, 1.5-6.0 amperes current range, 60 Hz, with current coil rated 5 amperes continuous, 0.2/2 ampere seal-in unit with target. Westinghouse Type CO, General Electric Type IAC, or equal.

C. Time Overcurrent (51N): Used to protect cables from phase-to-ground or phase-to-phase faults, 1.5-6.0 amperes current range, 60 Hz, with current coil rated 5 amperes continuous, 0.2/2 ampere seal-in unit with target. Cutler-Hammer Type CO, or equal.

D. Contractor shall field verify existing relays and match.

2.03 LOCKOUT RELAY (86)

A. Used to lockout or prevent reclosing of circuit breaker when a protective relay senses a fault condition. 125 volts, number of contacts specified, rated 2.0 amperes inductive, hand reset. Westinghouse Type WL, General Electric Type HEA, or equal.

2.04 AUXILIARY RELAYS

A. Auxiliary Relays 24V DC: Number of contacts specified, reversible type contacts, self-reset, flush mounted, Westinghouse Types MG-6 and SG, General Electric Types HFA and HGA, or equal.

B. Auxiliary Relays 120 VAC: Number of contacts specified, reversible type contacts, self-reset, flush mounted, Westinghouse Type MG-6, General Electric Type HFA, or equal.

2.05 NAMEPLATES

A. A lamicoid plastic nameplate, white face, ¾-inch high by 3 inches long shall be provided to identify each protective relay as specified.

2.06 FACTORY TESTING

A. Prior to shipping, all protective relaying circuits shall be completely assembled and tested for proper operation, continuity, and insulation resistance.

PART 3 - EXECUTION

3.01 GENERAL

A. Protective relays shall be installed as specified.

3.02 WIRING

A. All protective relays provided in switchgear shall be completely wired to terminal blocks including spare contacts. Wiring methods shall be as specified in the sections covering the specific switchgears or switchboards.

B. No conductors shall be routed across the rear of a device in a manner, which will cover or obstruct access to lead, terminals or devices.

C. Connection for all external wiring shall be terminated on conveniently located terminal blocks. Terminal block marking strips stamped with the conductor designations as shown on the elementary diagrams shall be provided.

D. Internal wiring shall be so designed so that only one external wire will be attached to each terminal point. Terminations shall be segregated and separated as to low voltage power, low voltage control, metering, and low-level signal circuits.

E. Twenty percent spare terminal points shall be provided.

3.03 GROUNDING

A. All protective relay cases shall be grounded effectively.

3.04 FIELD ACCEPTANCE TESTS

A. Protective relays shall be set as per Engineer's instructions. The Contractor shall, in addition to the tests described in Section 16000, retain the services of a qualified engineering appraisal and testing organization to perform the following tests:

1. Verify all relay settings and calibrations by inserting controlled currents and voltages into the relays.
2. Verify that all instrument transformers are of the correct ratio.

END OF SECTIONS 16430

SECTION 16440
DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of disconnect switches, fuses and enclosures. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition the following specific information shall be provided:

1. Product data including outline drawings with dimensions, and equipment ratings for voltage, capacity, horesepower and short circuit.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electrical Code.
2. NEMA, National Electrical Manufacturers Association
3. ANSI, American National Standards Institute.

1.04 QUALITY STANDARDS

A. All products covered by these specifications shall be in conformance with the NEMA standards and shall be UL approved.

B. Manufacturers offering products that comply with these Specifications include:

1. Disconnect Switches: General Electric, Siemens, Square D, Cutler-Hammer or equal.
2. Fuses: Bussmann, Gould, Littlefuse or equal.

PART 2 - PRODUCTS

2.01 DISCONNECT SWITCHES

A. Fusible Switch Assemblies: NEMA KS-1; FS W-S-865; quick-make, quick-break, 600 volt heavy duty load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: FS W-F-870; designed to accommodate fuses as specified in 16050-2.02.

B. Nonfusible Switch Assemblies: NEMA KS 1; FS W-S-865; quick-make, quick-break, 600 volt heavy duty load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: NEMA KS-1; Type as follows:

1. Indoors: NEMA 12.
2. Outdoors and Corrosive Areas: NEMA 4X nonmetallic.
3. Hazardous Areas: NEMA 7.

2.02 FUSES

A. Fuses 600 Amperes and Less: ANSI 198C, Class as specified in 16050-2.02. Equip with rejection feature where indicated.

B. Interrupting Rating: 200,000 rms amperes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install disconnect switches where indicated on Drawings.

B. Install fuses in fusible disconnect switches.

END OF SECTION 16440

SECTION 16445
SURGE PROTECTIVE DEVICE FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.01 GENERAL

A. The Surge Protective Device (SPD) covered under this section includes all surge protective devices suitable for use as Type 1 or Type 2 devices per UL1449 3rd Edition, applied to the line or load side of the utility feed inside the facility, at the Service Entrance and Distribution and Branch Panels, Switchgear, Motor Control Centers, and Switchboard assemblies, for low voltage (120-600V) equipment.

B. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to finish and install surge protective devices.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories. Package must include shop drawings complete with all technical information, unit dimensions, detailed installation instructions, maintenance manual, recommended replacement parts list and wiring configuration.

B. Field quality control test reports.

C. Operation and Maintenance Data.

D. Warranty Statement.

1.03 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

D. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

E. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, 3rd edition 2009 revision.

F. SPD shall be factory tested prior to shipment.

G. Ship the SPD components with the electrical equipment in accordance with the requirements specified in these specifications and protect the equipment from damage, dirt, dust, rain, and other elements.

1.04 PROJECT CONDITIONS

A. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 0 to 120 deg F.
3. Humidity: 0 to 85 percent, non-condensing.
4. Altitude: Less than 20,000 feet above sea level.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Current Technologies
2. Cutler-Hammer, Inc.; Eaton Corporation.
3. General Electric Company.
4. Siemens Energy & Automation, Inc.
5. Square D; Schneider Electric.

2.02 SWITCHBOARD SUPPRESSORS

A. Electrical Requirement:

1. Refer to Drawing for operating voltage, configuration and surge current capacity per mode for each location.
2. Declared Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage and in compliance with test and evaluation procedures outlined in the nominal discharge surge current test of UL1449 3rd Edition, section 37.7. MCOV values claimed based on the component's value or on the 30-minute 115% operational voltage test, section 38 in UL1449 will not be accepted.
3. Unit shall have not more than 10% deterioration or degradation of the UL1449 3rd Edition Voltage Protective Rating VPR) due to repeated surges. Unit shall have a monitoring option available to be able to test and determine the percentage of protective available at all times.
4. Each unit shall provide the following features:
   a. Integral disconnect switch.
   b. Field testable while installed.
   c. Phase Indicator lights, Form C dry contacts, surge counter and audible alarm.

d. Measuring capability to indicate the percent protective available in SPD.

e. Surge-event operations counter.

B. Peak Single-Impulse Surge Current Rating: 240 kA per mode or per Drawing, whichever is greater.

C. Connection Means: Permanently wired.

D. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of 480Y/277, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 800V for 480Y/277.
2. Line to Ground: 800V for 480Y/277.
3. Neutral to Ground: 800V for 480Y/277.

2.03 PANELBOARD SUPPRESSORS (480V)

A. Provide same as for Switchboard above, except:

1. Suitable for 480V, 3 phase, 3 wire or 480V 3 phase, 4 wire as applicable.
2. Surge Current Rating: 160kA per mode or per Drawing, whichever is greater.
3. Integral disconnect switch not required.

2.04 PANELBOARD SUPPRESSORS (208/120V)

A. Provide same as for 480V Panelboard Suppressors above, except:

1. Suitable for 208/120V, 3 phase, 4 wire.
2. Surge Current Rating: 90kA per mode or per Drawing, whichever is greater.
3. Integral disconnect switch not required.

B. Protection modes and UL 1449 suppressed voltage rating for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400V for 208Y/120.
2. Line to Ground: 400V for 208Y/120.
3. Neutral to Ground: 400V for 208Y/120.

2.05 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.01 INSTALLATION OF SURGE PROTECTION DEVICES

A. Each unit shall be installed per Manufacturer's recommended installation and wiring practices, as show on the drawing supplied.

B. Install devices for panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multi-pole, 30A, 60A, and 100A circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.02 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment, panelboards, or control terminals to their sources until surge protection devices are installed and connected.

3.03 FIELD QUALITY CONTROL

A. Testing: The SPD manufacturer's technician shall perform a system checkout and start-up in the field to assure proper installation, operation and to initiate the warranty of the system. The technician will be required to do the following:

1. Verify voltage clamping levels using the DTS-2 test equipment.
2. Verify N-G connection when applicable.
3. Record information to product signature card for each product installed

3.04 PRODUCT WARRANTY

A. Warranty on defective material and workmanship for term of 10 years from the date of substantial completion.

B. Copy of Warranty to be sent with submittal.

C. Manufacturer shall warrant all equipment provided under this Section to be free of defects in materials or workmanship for a period of at least one year starting on the date of substantial completion. In general, the substantial completion date will occur prior to commencement of the acceptance tests and 120-day Whole Plant Testing. Warranty periods will not start based on date of delivery of the equipment.

3.05 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and installer, to ensure that coatings, finishes, and cabinets are without damage or deterioration at Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to paint finishes with matching touch-up coating recommended by the manufacturer.

3.06 TRAINING

A. Provide a minimum of 1-hours of training for all similar TVSS systems.

3.07 CLEANING

A. Upon completion of installation of system, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 16445

SECTION 16450
GROUNDING

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete installation of grounding system. All work shall be installed, adjusted and tested in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract Drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Test Reports: Submit directly to the Engineer two copies of the test reports certified by the testing technician.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, Article 250.
2. IEEE 81-83.

1.04 DELIVERY, STORAGE AND HANDLING

A. Materials shall be delivered to the site and stored in the area assigned.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ground rods shall be ¾ inch diameter by 10 feet long, copper-clad steel, Josyln, or equal. Ground rods shall be sectional type with threaded type removable caps and coupler, where lengths greater than 10 feet are required.

B. Conductors shall be stranded copper, except that No. 6 A.W.G., when installed bare, shall be solid. When installed in raceways, conductors shall have specified 600 volt insulation, color coded green.

C. Exposed or accessible connections shall be made with copper or bronze grounding clamps, lugs, through-bolts, or other fittings specifically intended for such use such as grounding bushings, etc. Underground or other inaccessible connections shall be made by the exothermic welding process.

D. Aluminum grounding materials will not be accepted.

PART 3 - EXECUTION

3.01 APPLICATION

A. Items to be grounded shall include, but not necessarily be limited to, the following:

1. Steel building structures and all other above-ground metal structures.
2. Metallic raceways.
3. Electrical equipment enclosures.
4. Electrical system neutrals, only, at the point of supply.
5. Ground buses of switchboards, motor control centers, panelboards, etc.
6. Grounding pole of all receptacles.
7. Lighting fixture housings, outdoor metal light poles, etc.
8. Motors and other electrically operated equipment.
9. Outdoor metal fences.
10. Telephone service equipment (provide grounding leads only).
11. Lightning arresters (where required).
12. Medium and/or high voltage structures, housings, hardware, cable shields, static wires, etc., where applicable, other than items which are Utility Company owned.
13. Transformers.
14. Any equipment likely to become energized due to a malfunction
15. Ground grid systems with ground rod and water pipe connections.

3.02 INSTALLATION

A. The grounding installation shall conform with requirements indicated on the drawings and with the following:

1. Ground rods shall be driven vertically with top of rod 4" below grade, except that, where solid rock is encountered, rods may be tilted or, where necessary, may be placed horizontally.
2. Below grade grounding loops, mats and/or leads shall consist of 4/0 bare stranded copper cable not less than 2'-6" below the finished surface. Where indicated to be outside of building perimeter or other structure lines, foundation pads, etc., conductors shall be located

not less than 3 feet, horizontally, outside of building foundations or from the edge of pads, etc.

3. Grounding risers shall be properly located so as not to comprise an obstruction or hazard to vehicle or pedestrian traffic. Risers for grounding steel columns shall rise within the concrete piers but shall clear column base-plates. Connections to exposed columns shall be "CADWELD" or "THERMO-WELD" type, located approximately 12 inches above the finished surface, and shall be made to the web of H shapes and to the inner surface of channels or angles. Connections to furred or otherwise inaccessible columns shall be made by brazing or welding. Risers to floor mounted equipment, such as switchboard, motor control centers, etc., shall be accessibly located under the equipment and be connected with bolted lugs. At permanent walls risers intended for extension within the building shall rise into an adequately sized junction box, surface or flush mounted to match other wiring within the area, approximately 1 foot above the floor, from which it shall be extended as insulated wire in conduit to the item or items to be grounded. Risers for extension or connection by others shall be left with approximately 4 feet of conductor coiled.

4. Grounding jumpers shall be provided between the building grounding system or the grounded building structure and every incoming metal underground cold water pipe, including all sprinkler risers where such exist.

5. Size of grounding conductors shall not be less than called for on the drawings, and otherwise shall not be less than the following:
   a. 4/0 A.W.G. for all buried or otherwise inaccessible conductors.
   b. For grounding A.C. system neutrals, as required by N.E.C. Table 250-94.
   c. For raceway and equipment grounding, as required by N.E.C. Table 250-95.
   d. No. 2 A.W.G. where installed exposed.
   e. For grounding low voltage ground buses, as required by NEC Table 250-94.

6. Grounding conductors, insulated and color coded green, shall be provided in all low voltage feeder and sub-feeder and branch circuit conduit runs, except low voltage service entrance conduit runs which contain a grounded neutral. These grounding conductors shall be connected to all metallic conduits by means of approved grounding bushings at all conduit terminations at the supply end of such circuits.

7. Outdoor metal fences provided under this Contract shall be bonded in not less than 3 places to an underground 4/0 grounding conductor extending not less than 25 feet on each side of the overhead line with not less than 3 ground rods bonded thereto, one in the center and one at each extremity. Fences around outdoor electrical substations shall be bonded to the substation grounding loop or grid at each corner post, at each gate post, and otherwise at points not greater than 25 feet apart, with flexible bonding jumpers provided for each gate.

8. Install sufficient ground rods in addition to code required grounding so that resistance to ground as tested by standard methods does not exceed 2 ohm unless otherwise accepted. Where more than one rod is required, install rods at least 10 feet apart.

9. Provide a bare conductor through each ductbank, connected to manhole/handhole ground rod. Connect to building ground grid or equipment frame as applicable.

10. Provide a logic ground for main computer and each PLC based local control panel separate from the power system ground. Route a 1/0 insulated copper conductor in a ¾-inch conduit to a ground cluster outside the building.

11. Were the manufacturer of equipment supplied from 120 volt instrument power panels requires an isolated ground, the Contractor shall provide an additional isolated ground

conductor from the equipment through the instrument power panel for connection to a ground cluster outside the building. The isolated ground conductor shall have green insulation with a yellow stripe and shall be run in the same raceway as the power and neutral conductors.

3.03 GROUNDING CONNECTIONS

A. Unless shown otherwise, make connections of grounding conductors to ground rods at the upper end of the rod with the end of the rod and the connection point below finished grade. Provide ground well, as shown on the Drawings to allow for inspection.

B. Make connections of sections of outdoor ground mats (counterpoise) for substations or other equipment underground. Make connections of other grounding conductors generally accessible.

C. In handholes and manholes, install ground rods with ends 4 to 6 inches above the floor with connections of duct bank grounding conductors fully visible and accessible.

D. When making thermo welds, wire brush or file the point of contact to a bare metal surface. Use thermo welding cartridges and molds in accordance with the manufacturer's recommendations. After welds have been made and cooled, brush slag from the weld area and thoroughly clean the joint. For compression connectors, use homogeneous copper, anticorrosion, surface treatment compound at connectors in accordance with connector manufacturer's recommendations. Use connectors of proper size for conductors and ground rods specified. Use connector manufacturer's compression tool. Notify Engineer prior to backfilling any ground connections.

E. Compression connectors shall be cast copper as manufactured by Thomas and Betts or equal.

3.04 EQUIPMENT GROUNDING

A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment with copper wire sized in accordance with NEC. Grounding conductors installed in conduit furnished with green, 600-volt insulation.

B. Connect transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.

C. Connect two separate ground connections from ground grid to ground bus of switchgear assemblies, motor control centers and all outdoor substation equipment. Ensure that each connection for item of equipment is from different section of ground grid.

D. Install a separate grounding conductor from ground system to motors of 480 volts and higher, in addition to raceway system. Ground motor ground connection to motor frame, independent of mounting bolts or sliding base. Ground motor to nearest point on grounding system, unless otherwise indicated.

E. Connect lightning arrestors to ground system by suitable conductors.

F. Ground each street lighting standard by ground rod driven near base of standard, in accordance with requirements of NEC. Connect ground rods to grounding connector brought with street lighting feeder cable.

G. Where lightning arrestors are furnished with electrical equipment and grounding connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arrestors with system ground.

H. Bond service entrance equipment ground bus in each building to the ground grid with a #4/0 bare copper conductor.

3.05 FIELD TESTS

A. Test in the Engineer's presence the ground resistance of the grounding system.

B. The Contractor shall test the resistance of the grounding electrode system by the fall-of-potential method. The Contractor shall supply a Biddle No. 6322 Earth Tester, or equal, and make the test in the presence of the Engineer with grounding conductors disconnected. If the grounding electrode test resistance exceeds 1 ohm, the Contractor shall add ground rods or other grounding electrodes to the grounding electrode system until the grounding electrode test resistance is 3 ohms or less. Methods which change soil resistivity are not acceptable as means of lowering the grounding electrode test resistance. This test shall not be made within 24 hours after rainfall.

C. Test all ground fault circuit interrupter (GFCI) receptacles and circuit breakers for proper connection and operation with methods and instruments prescribed by the manufacturer.

D. Provide copies of reports of all grounding system tests for inclusion in Operation and Maintenance Manuals and for review by the Engineer.

END OF SECTION 16450

SECTION 16461
DRY TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of dry type two winding transformers. All dry type transformers shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. the following specific information shall be provided:

B. Product data. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.

B. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Equal to:

1. Cutler-Hammer.
2. Schneider Electric.
3. Siemens.
4. General Electric.

2.02 DRY TYPE TRANSFORMERS

A. Dry Type Transformers: NEMA ST-20; factory-assembled, air-cooled dry type transformers; ratings as indicated. Transformers shall be two winding power type. Three phase units shall be connected delta primary and wye secondary. Scott or Tee connections and autotransformers are not acceptable.

B. Insulation: 220 degrees C, 115 degree C rise for ratings 30 kVA and larger; 185 degrees C, 80 degree C rise for ratings below 30 kVA.

C. Taps: Two, 5% below rated primary for ratings smaller than 15 kVA; six, 2-1/2% two above and four below rated primary for ratings 15 kVA and larger.

D. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

E. Mounting: Transformers 75 kVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 kVA shall be suitable for floor or trapeze mounting.

F. Isolate core and coil from enclosure using vibration-absorbing mounts.

G. Specialty transformers shall be provided as indicated on the Contract Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Set transformer plumb and level. Clear walls and ceilings by at least 6 inches to allow for air circulation.

B. Use flexible conduit, 2 ft minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.

3.02 FIELD QUALITY CONTROL

A. Check for damage and tight connections prior to energizing transformer.

B. Measure secondary voltage under normal load conditions and make appropriate tap adjustments.

END OF SECTION 16461

SECTION 16470
PANELBOARDS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of panelboards. All panelboards shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Quality and rating of circuit breakers provided with each panelboard.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electrical Code.
2. Ul, Underwriters Laboratories.
3. NEMA, National Electrical Manufacturers Association.

1.04 QUALITY STANDARDS

A. The panelboards covered by these specifications shall be designed, tested and assembled in accordance with the following standards:

1. NFPA 70, National Electric Code (NEC).
2. UL67, Underwriters Laboratories, Electrical Panelboards.
3. UL489, Modeled Case Circuit Breakers and Circuit Beaker Enclosures.
4. UL50, Cabinet and Boxes.
5. NEMA PB-1, Panelboards.

B. Manufacturers offering products that comply with these Specifications include:

1. General Electric.
2. Siemens.
3. Square D.
4. Cutler-Hammer.
5. Or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 GENERAL

A. Panelboard schedule is shown on the drawing.

2.02 PANELBOARDS

A. Panelboards: NEMA PB-1; UL 67.

B. Rating: Voltage and ampere ratings are shown on the Drawings. Unless otherwise indicated interrupting ratings (RMS symmetrical) are 65,000 amps for 480 volt panelboards and 65,000 amps for 240 and 208 volt panelboards.

C. Boxes: Code gage galvanized steel; sized to accommodate devices indicated and afford wire bending space in accordance with NEC requirements.

D. Fronts: Surface or flush as indicated, dead front construction, finished in light grey enamel over a rust inhibitor. Furnish flush lock for fronts less than 48 inches high and vault type handle with three point catch for fronts 48 inches and higher. Key all locks alike.

E. Provide copper busbars full sized throughout their length. Make complete provisions for mounting future circuit breakers throughout the full length of the bus provided regardless of the number of units and spaces called for. Provide all machining, drilling, or tapping required to add or change circuit breakers in the future. Bolt together and rigidly support bus bars and connection straps on molded insulators.

F. Furnish an insulated neutral bus bar rated the same as the phase bus bars and having at least one terminal screw for each branch circuit. Furnish a copper ground bus bar installed on the panelboard frame, bonded to the box, and containing at least one terminal screw for each circuit.

G. Circuit Breakers: NEMA AB-1; molded case type, thermal-magnetic trip with internal common trip on multipole breakers. Provide breaker fully rated for interrupting ratings noted; series ratings are not acceptable. Furnish circuit breakers in locations where diagram or schedule indicates spare. Furnish only complete provisions for future circuit breakers where indicated space. Breakers shall be bolt-on type, listed in accordance with UL489 for the service specified, and rated for 500 C environment.

H. Provide engraved nameplates giving the voltage rating and panel designation as indicated. Provide a UL service entrance label for panelboards used as service entrance equipment.

I. Two section panels: Box and front same height each section.

J. Furnish ground fault interrupted circuit breakers for certain circuits as indicated on the Drawings.

K. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.

2.03 SURGE PROTECTIVE DEVICE

A. A surge protective device shall be furnished and installed with the panelboards. Refer to SECTION 16445 – SURGE PROTECTIVE DEVICE FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install boxes so they are rigidly supported and correctly aligned. Select mounting height so that operating handles are not higher than 6 feet 6 inches or lower than 24 inches above the floor.

B. Prior to energizing panelboards clean out construction dirt and debris. Paint any scratches on the trims or dead front barriers. Meggar each phase to phase and to ground to insure that no short circuits exist.

C. Adjust panel barriers so that no openings occur between them and the panel front. Provide filler plates and plugs as necessary to maintain dead front integrity.

D. Type directory cards with circuit loads and/or area served. Note spare circuits in pencil. Provide a directory holder with clear plastic plate and metal frame on the inside of the door.

3.02 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

3.03 TESTING

A. Panelboards shall be tested for proper operation and function per Section 16999.

END OF SECTION 16470

SECTION 16475
FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following: Fuses.

1.03 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each fuse type specified.

C. Product Data for each fuse type specified. Include the following:

1. Descriptive data and time-current curves.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Fuse size for elevator feeder and disconnect applications.

D. Field test reports indicating and interpreting test results.

E. Maintenance data for indicating and interpreting test results.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. See also Spec 16010 Part 1 for listing of applicable reference standards.

1.05 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses: Furnish Quantity equal to 20 percent of each fuse type and size installed, but not less than one (1) set of three (3) of each type and size.
2. Fuse Holder: Furnish one fuse holder for all projects that require more than 100 fuses.
3. Fuse Puller: Provide one fuse puller for each of the fuse sizes as necessary and recommended by the manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries, Inc.; Bussman Div.
2. General Electric Co.; Wiring Devices Div.
3. Gould Shawmut.
4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

2.03 SPARE FUSE CABINET

A. Cabinet: Wall-mounted, 0.05-inch (1.27 mm) thick steel unit with full-length, recessed piano-hinged door with key-coded cam lock and pull. Mount cabinet in main electrical or mechanical room.

1. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identifications: Stencil legend "SPARE FUSES" in 1-1/2-inch (40 mm) letters on door.
4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

A. Main Service: Class RK1, time delay.

B. Main Feeders: Class RK1, time delay.

C. Motor Branch Circuits: Class RK1, time delay.

D. Other Branch Circuits: Class RK5, non-time delay.

3.03 INSTALLATION

A. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

3.04 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION 16475

SECTION 16481
LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of low voltage motor control centers. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Motor horsepower ratings and enclosures shown are what is expected. This information is for guidance only and does not limit the equipment size. When motors furnished differ from the expected ratings indicated, obtain the Engineer's review before proceeding.

D. Related Work specified elsewhere:

1. Section 16000 - Electrical Power and Systems.
2. Section 16050 - Basic Electrical Materials and Methods.
3. Section 16120 – Wire and Cable.
4. Section 16450 - Grounding.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Elementary diagrams. Provide a separate elementary diagram for each starter unit following the format shown on the Contract Drawings and showing numbered terminal points and interconnections of remote devices.
2. Reference Data. Submit one set of full size (11" x 14") time current curves on log-log transparency paper for all overcurrent protective devices. Exception: A tabulation of heater sizes or elements versus motor current rating may be submitted in lieu of time current curves for overload relays.
3. Operation and maintenance data including recommended maintenance procedures and intervals, spare parts listing, and instruction books for the equipment and components.
4. List of starters and feeder compartments indicating the size and type of current protection.

1.03 QUALITY ASSURANCE

A. Reference Standards. Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEMA, National Electrical Manufacturers Association.
2. UL, Underwriters laboratories.

B. Provide a UL label where applicable, on each unit and each vertical section. If a unit or section cannot be UL labeled so note on submittals along with reasons for same.

1.04 QUALITY STANDARDS

A. Provide motor control centers manufactured and tested in accordance with NEMA ICS-2 and UL 845.

B. Manufacturers offering products that comply with these specifications include:

1. General Electric 8000 Line.
2. Cutler-Hammer 2100 Series Freedom & Advantage.
3. Allen Bradley Centerline.
4. Square D Model 4.
5. Or equal and newer models.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Arrange shipping splits as required for installation. Individually wrap each section and mount on shipping skids.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

PART 2 - PRODUCTS

2.01 RATINGS

A. Service: 480 Volt, 3 Phase, 60 Hz.

B. Short Circuit: Unless otherwise indicated device interrupting rating and bus bracing is 100,000 amperes rms symmetrical. Provide fully rated devices; series ratings are not acceptable.

C. Ampacity: See Contract Drawings Rating to be in accordance with UL standards for temperature rise and a half size neutral bus where specified.

2.02 CONSTRUCTION

A. Equipment consists of the required number of vertical sections to accommodate all devices indicated and specified herein, each nominally 90 inches high and 20 inches deep. Sections are bolted together to form a rigid free standing, front accessible, dead front assembly. Only 72 inches must be used for mounting starters and breakers.

B. Provide each section with isolated horizontal wireways at the top and bottom and isolated vertical wireways with hinged door and cable tie supports. Unused spaces are to have bussing for future units and blank door covers.

C. Indoor enclosures shall be NEMA 1A gasketed painted in the manufacturer's standard grey over a rust inhibitor treatment. Outdoor enclosures shall be NEMA 3R, non-walkin.

2.03 INCOMING MAINS

A. Provide incoming main circuit breaker if shown on the drawing. Main breaker shall be molded case type with thermal magnetic trips meeting UL 489 and NEMA AB-1.

B. Arrange main breaker for cable entry without requiring 90 degree bends in the incoming conductors.

C. Where motor control centers serve as service entrance equipment, provide a UL service entrance label on the incoming section.

2.04 STARTER UNITS

A. Starters: Motor circuit protector combination type with contactor rated in accordance with NEMA size designations. Fractional sizes and ratings per IEC recommendations are not acceptable. Minimum size shall be 1.

B. Breakers: Adjustable magnetic trip only equipped with current limiters as required for the interrupting rating noted.

C. Contactors: NEMA 165-2; NEMA Size 1 minimum; magnetically held; field replaceable coil and contacts; auxiliary contacts field installable and removable. Terminal temperature rise is not to exceed 500 C per NEMA standards. Provide two normally open and two normally closed auxiliary contacts, rated 10 amperes at 120 volts AC, wired out to terminal blocks, unless otherwise shown on the Drawings.

D. Overload Relays: Overload relay shall be provided with three heater elements; ambient compensated; adjustment from 90 to 110 percent of normal heater ratings; solid state overload relays; normally closed, isolated auxiliary contact; manually reset by means of an external reset button; and capable of handling the horsepower range of the starter by changing the thermal elements only. Provide one (1) three phase sets of N.O. or N.C. contact of the overload as shown on the drawings for each starter.

E. Units: Constructed to fully compartmentalize the starter and arranged to permit access to starter, control power transformer, fuses, and other components without requiring disassembly. NEMA size 1 thru 4 are plug in, size 5 and larger are bolt on. Equip unit door with a defeatable interlock

to prevent opening unless the disconnect is open. Equip disconnect operator to accommodate three padlocks in the "OPEN" position.

F. Terminal Blocks: Pull apart type for power and control to allow unit withdrawal without disconnecting wiring. Use screw type terminals suitable for ring and tongue lugs for control wiring and box lug type for power wiring.

G. Provide an encapsulated surge suppressor for each starter unit, for direct mounting to the starter coil. Suppressor shall be rated 120VAC, with no additional panel space required.

H. Motor control centers shall be provided with NEMA Class I, Type "B" wiring. Provide terminal blocks for control wiring as shown on the Drawings. Terminal blocks shall be provided for power wiring for starter size 2 and smaller. Control wiring shall be lugged with ring-tongue or locking spade crimp type terminals made from electrolytic copper, tin-plated.

2.05 FEEDER UNITS

A. Breakers: Molded case type, thermal-magnetic trips meeting UL 489 and NEMA AB-1. Ampere rating and interrupting ratings as noted.

B. Units: Individually compartmentalized with not more than one breaker per unit unless otherwise indicated. Use red color to indicate on position as described above for starter units.

C. Breaker shall be equipped with toggle type handle, quick-make, quick-break mechanism, ON-OFF position clearly indicated. Minimum short circuit capacity 100,000 amps.

2.06 BUS

A. Material: Copper, tin plated at all joints.

B. Isolation: Locate main bus at the top or center, completely compartmentalized with sliding or removable barriers for access to joints. Provide phase isolation for vertical bus by polyester barriers enclosing each phase bar or providing adequate creepage to restrict fault propagation. Plug all holes not used to stab in units.

C. Provide ground bus rated 300 amps minimum extending the full length of the lineup. Where three phase, four wire control centers are indicated provide full length neutral bus rated a minimum of 50 percent of the main bus. Where three phase three wire control centers are used as service entrance equipment provide neutral bus in the incoming main section only.

2.07 METERING RELAYING AND CONTROL DEVICES

A. Instrument transformers and metering devices shall meet the requirements of Section 16175.

B. Elapsed time indicator: Six digit, non reset, 3-½-inch square case; equal to GE type 236.

C. Indicating lights, pushbuttons and selectors: Heavy duty, oiltight, industrial grade with octagonal ring. Pilot lights are transformer type. Equal to Allen Bradley Bulletin 800T.

D. Control Relays: Heavy duty, 600 volt, industrial grade, 10 amp contact rating. Equal to Allen Bradley bulletin 700 type P.

E. Supply individual control power transformers where indicated. The transformers shall have sufficient capacity to serve the connected load plus 100 VA and limit voltage regulation to 15 percent during contactor pickup. Fuse one side of the secondary winding and ground the other side. Provide two primary, current limiting fuses. Provide each starter unit with blown fuse indicators.

F. Each starter unit shall be provided with a motor control circuit disconnecting device that meets the requirements of NEC 430-74(a).

2.08 SPARE PARTS

A. Starter Contacts: One (1) set for each NEMA size furnished.

B. Starter Coils: One (1) for each NEMA size furnished.

C. Control Circuit Fuses: Three (3) for each rating furnished. Provide one (1) fuse puller.

D. Pilot Light Lamps: Standard lot cartons equal to ten (10) percent of the number of lights furnished, one carton minimum.

E. Touch-Up Paint: One (1) can.

2.09 NETWORKING

A. MCC shall be ModBus compatible. Connect to PLC, pump monitoring panels, and local control panels.

2.10 SURGE PROTECTIVE DEVICE

A. A surge protective device shall be furnished and installed with the MCC. Refer to SECTION 16445 – SURGE PROTECTIVE DEVICE FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with the manufacturer's instructions.

B. Settings: Install the adjustment stop pin on magnetic only breakers so that the adjustment cannot exceed 13 times the full load amps. When the line voltage is at or above its normal value, adjust each magnetic only breaker to the lowest value that will allow reliable starting. Install the correct thermal overload relay element in each motor starter. The sizing of the overload element shall be based on motor nameplate amps, motor service factor, expected difference between motor and starter ambient temperature, any other factors the starter manufacturer requires. Prepare a table of motor name, motor horsepower, nameplate full load current, heater catalog number, heater current range, protective device trip setting, and include a copy in the Operations and Maintenance Manual.

C. Install control centers on 4-inch concrete pads and secure to sills imbedded in the concrete with ½-inch threaded bolts and nuts.

D. Touch up paint scratches and vacuum to remove construction debris and dirt. Install all doors, wireway covers etc., and plug any unused device holes.

3.02 TESTS

A. Install overload relay thermal elements based on motor nameplate rating. If capacitors are installed between the relay and motor, select thermal elements based on the measured motor current. Adjust other overcurrent protective devices to settings per the coordination study.

B. Megger each bus, phase-to-phase and phase-to-ground.

C. Motor control centers shall be tested in accordance with Section 16999, Acceptance Testing and Calibration

END OF SECTION 16481

SECTION 16485
CONTACTORS

PART 1 - GENERAL

1.01 SCOPE

A. Lighting contactors.

B. Enclosures.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

B. Product data: Include outline drawings with dimensions, and equipment ratings for voltage, capacity, and poles.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. General Electric.

B. Square D.

C. Cutler-Hammer.

D. Or equal.

2.02 LIGHTING CONTACTORS

A. Contactors: NEMA ICS-2; electrically held, 2 wire control.

B. Coil Operating Voltage: 120 volts, 60 Hertz.

C. Contacts as indicated.

D. Enclosure: NEMA ICS-6; Type 1.

E. Provide solderless pressure wire terminals.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION 16485

SECTION 16486
REDUCED VOLTAGE SOFT STARTERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials, equipment and incidentals required, and install, place in operation and field test solid-state starter (s).

B. The solid-state starter(s) shall be microprocessor controlled, suitable for use with three phase induction motors rated 600 VAC or less. The starter(s) shall provide a closed loop current ramp for smooth and stepless motor acceleration and deceleration.

C. The solid-state starter(s) must fit in the space indicated on the drawings.

1.02 QUALITY ASSURANCE

A. The solid-state starters shall be the product of a manufacturer who has produced solid-state starters of the same type and size for a minimum of 10 years consecutive.

B. Codes: Provide equipment in full accordance with the latest applicable rules, regulations, and standards of:

1. Local Laws and Ordinances
2. State and Federal Laws.
3. National Electric Code (NEC)
4. Underwriters Laboratories (UL)
5. American National Standards Institute (ANSI)
6. National Electrical Manufacturers Association
7. Institute of Electrical and Electronics Engineers (IEEE).

C. The solid-state starter(s) shall be UL listed.

D. Acceptable Manufacturers:

1. Benshaw.
2. Eaton, Cutler Hammer.
3. Square D.
4. Allen-Bradley.
5. General Electric Company.

E. Environmental Requirements:

1. Temperature: 0 degrees C to + 50 degrees C (32 degrees F to 122 degrees F)
2. Storage Temperature -20 degrees C to + 70 degrees C (-4 degrees F to 155 degrees F)

3. Relative Humidity: up to 95%, non-condensing
4. Suitable for use in H2S concentrations per OSHA regulations for continuous worker exposure.
5. Input Power: 200-600V AC, 3 Phase, +/- 10% 50-60 Hz, +/- 3 Hz.
6. Meet Uniform Building Code on non-building structures for zone requirements.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions.

B. Provide the following:

1. Elementary wiring and interconnection diagrams in accordance with NEMA ICS standards.
2. Size, type, and rating of all system components
3. Enclosure frontal elevation and dimension drawings.
4. Internal component layout diagrams.
5. Available conduit entry and exit locations.
6. Manufacturer's product data sheets.

1.04 WARRANTY

A. Equipment furnished herein shall include a minimum of one year manufacturer's warranty from date put in service.

1.05 DELIVERY, STORAGE AND HANDLING

A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.

B. Equipment shall be stored indoors in a clean, dry environment. Energize space heaters if furnished.

PART 2 - PRODUCTS

2.01 EQUIPMENT DESIGN CRITERIA

A. At a minimum, the Starter(s) shall conform to the following:

1.	Size:	As shown on Contract Drawings (or smaller)
2.	Minimum Overload Rating:	500% of Starter FLA for 30 sec., 125% cont.
3.	PIV Ratings:	1,800V Minimum
4.	Rated Short Circuit Amps:	65KAIC Minimum
5.	Insulation Test:	2,500VAC Minimum
6.	Overall Efficiency w/o Bypass:	Average 99.7%
7.	Overall Efficiency w/Bypass:	99.94%

8.	SCR Firing Technique:	Hard Drive with "picket fence"
9.	Transient Voltage Protection:	dV/dT circuits or SIOV/ phase
10.	Under voltage Protection:	80% Pickup; 60% Dropout
11.	Control Input:	120 VAC or dry contact, 2/3 wire.
12.	Max Time Between Restarts:	Not more than 2 minutes
13.	Audible Noise:	Not to exceed 60dbA @ 1 meter at any time
14.	Network:	ModBus compatible. Connect to PLC, pump monitoring panels, and local control panels.

2.02 ENCLOSURE CONSTRUCTION

A. NEMA 1, Construct to comply with NEMA Part ICS 2.

B. Provide incoming fused disconnect switch suitable for padlocking and external operation. Furnish complete with current limiting fuses.

C. Basic structure shall be welded type construction utilizing minimum 14 GA sheet metal.

1. Doors shall be minimum 14 GA sheet metal, pan type with flanges formed to provide sturdy, rigid structure.
2. Door latches and hinges capable of holding door closed during maximum fault condition.
3. Provide door interlocks to prevent doors from being opened with power applied
4. Provide removable lifting provisions on floor mount enclosures.

D. Finish:

1. Metal parts to be given thorough rust resistant treatment.
2. Primer shall be Manufacturer's standard.
3. Finish shall be Manufacturer's standard.
4. Color shall be Manufacturer's standard.

E. Complete with internal power and control wires including terminations for external connections. Phase sequencing shall have proper identification and control wires shall have suitable markings at terminations.

2.03 MAIN AND BYPASS CONTACTORS

A. Inline (main) contactor and a bypass contactor shall be provided.

1. Full rated (IEC rated contactors are not acceptable)
2. Current rating: Manufacturer standard for horsepower rating.
3. Voltage rating: Up to 600 VAC.
4. The main and/or bypass contactor shall be sequenced by the Starter manufacturer for proper operation of the solid-state starter.

5. The bypass contactor shall bypass the SCRs after starting and while the starter is in the run (full voltage) mode.

2.04 CONTROL DEVICES

A. Control Power Transformer

1. Provide an appropriately rated (but not less than 1 kVA) internal 480V-120VAC step-down transformer.
2. Supply two fuses on primary and one fuse on secondary side with one leg grounded.

B. Control Wiring: minimum 16 GA stranded, rated for 600V.

C. Terminal Strips: Rated for 600V, suitable for contractor termination of up to 10 GA wire.

D. Hand-Off-Auto selector switch, push buttons, pilot lights, and control relays, heavy duty, rated to 600V. Include at a minimum control devices as shown on the Project Contract Electrical and P&ID Drawings.

2.05 SOLID STATE STARTER LOGIC CONTROL

A. Provide a door mounted Display & User Interface Module with the following functions

1. Backlit LCD- 2 Lines, 16 Characters
2. Tactile Feedback Buttons
3. Pass Code Protection
4. Built in Start/Stop Pushbuttons
5. Status Indication via LCD Display and LED's
6. Scrolling Menu/Parameters
7. Discrete Enter Command Button
8. Meter Mode Display
9. Selectable Meter Mode Scroll Rate

B. Programmable Motor Control Functions

1. Motor Starting/Running
   a. Programmable Current Ramp
   b. Ramp to Limit
   c. Full Voltage Start
   d. Initial Current Limit (50-600%)
   e. Start Ramp Time (0-300 Sec.)
   f. Maximum Current (100-800%)
   g. Dual Kick Start (0.1-10 Seconds)
   h. Dual Ramps
   i. Programmable 1-6,400 Amps
   j. Motor Service Factor (1.0 – 1.99)

k. Torque Ramp
l. Power Ramp
m. Voltage Ramp

2. Motor Stopping
   a. Fully Programmable "S" Curve Pump Decel
   b. Soft Stop
   c. Auxiliary Motor Feeder Control

3. Interlocking/Logic
   a. Overload Lockout
   b. Assignable Digital Relay Outputs (3)
   c. Frequency Tracking
   d. Up to Speed Indication/Contact
   e. Preassigned Digital Inputs (4)
   f. Analog Input
   g. 4-20mA analog output

4. Maintenance
   a. Emergency Restart After Fault Lockout
   b. Selectable CT Ratios
   c. Current Limited Jog
   d. Factory Control Mode for Supervisory Control (Optional)
   e. Real Text Event Recorder

C. Programmable Motor Protection Functions

1. Motor/Machine Faults
   a. Electronic Overload
   b. Selectable Overload Curves, Class 1-40
   c. Overload Reset
   d. Overload Warning
   e. Acceleration Time
   f. Instantaneous Overcurrent
   g. Motor Thermal Capacity Protection
   h. Undercurrent Alarm (Selectable Trip or Warning)
   i. Time Between Restarts
   j. Machine Ground Fault Protection

2. Electrical System Faults
   a. Undercurrent Protection
   b. Current Unbalance (10-40%)
   c. Undervolt Protection (10-30%)
   d. Protection (10-30%)
   e. Phase Reversal Protection
   f. Underfrequency Protection

g. Overfrequency Protection
h. Overload Alarm
i. Ground Overcurrent Protection

D. Diagnostics Functions

1. Alpha/Numeric Fault Display
2. Motor Thermal % Capacity Display
3. Closed Loop Motor Stall Detection
4. Open Loop Motor Stall Detection
5. Starter Status Indication
6. Pre-Start: Pending Fault Indication
7. Pre-Start: Phase Rotation Indication
8. LED Indication SCR Status
9. Full Screen Meter Mode

E. Metering Functions

1. Standard Meter Displays:
   a. Average Current
   b. Current, L1
   c. Current, L2
   d. Current, L3
   e. Percent Current Imbalance
   f. Ground Fault Current
   g. Average Voltage
   h. Voltage, L1- L2
   i. Voltage, L2 - L3
   j. Voltage, L3 -L1
   k. Line Frequency (50-60Hz)
   l. % Overload
   m. Run Time - Day
   n. Run Time - Hour
   o. Watts
   p. Kilowatt Hours
   q. Megawatt Hours
   r. Phase Order
   s. # Of Starts
   t. Tru Torque %
   u. Power %
   v. Power Factor

F. Programmable Relay Outputs

1. Standard Programmable Relay Outputs
   a. Overload
   b. Overload Lock
   c. Overload Warn
   d. Running
   e. Up To Speed
   f. Shunt Trip NFS
   g. Shunt Trip FS
   h. Ground Fault
   i. Over Current Trip
   j. Under Current Trip
   k. Energy Saver
   l. Starter Ready
   m. Heating
2. Output relay contacts shall be rated 5 Amps inductive and 16 Amps resistive.

G. Programmable Analog Outputs

1. Provides minimum four (4) programmable analog outputs.

2.06 LABELING

A. Each control panel or cabinet shall be provided with exterior nameplate that identifies the panel in accordance with the panel name and description as shown on the Contract Drawings. Nameplates shall be at least 1-inch high x 3-inch wide constructed of plastic laminate that is at least 1/16 inch (1.6 mm) thickness for nameplates up to 20 square inch (129 square cm) or at least 1/8 inch thick (3.2 mm) for larger sizes. Nameplate shall be engraved using a "sans serif" type font like Arial or Helvetica typefaces. Lettering shall be approximately ¼" in height, consisting of White Lettering on a Black background. Nameplates shall be beveled and attached to panels by self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers. Nameplates that are only adhesive bonded or glued to the panel or cabinet shall not be accepted.

B. Additionally each control panel or cabinet shall be provided with nameplates identifying each component, selector switches, pilot lights, and all internal components and etc. Nameplates shall be laminated plastic, engraved white letters with a black background. Nameplates shall be mounted adjacent to but not on each component. Nameplates shall be permanently affixed with stainless steel self-tapping screws.

C. Where applicable, also provide a nameplate, which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Engraving shall be approximately 3/16" in height, consisting of black lettering on a high visibility yellow background. Nameplates shall be beveled and attached to panels by self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers. Adhesive bonded or glued on nameplates shall not be accepted.

PART 3 - EXECUTION

3.01 TESTING

A. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.

B. Power semiconductors shall be fully tested for proper electrical characteristics, including dv/dt and di/dt.

C. All subassemblies shall be inspected and/or tested for conformance to quality assurance specifications.

D. Each completed unit shall be functionally tested prior to shipment to assure conformance to the Specifications.

3.02 STARTUP AND TRAINING

A. Contractor shall include two visits, consisting of two consecutive days each, for startup and training. Services shall include startup of equipment and field/classroom training for Owner's personnel. Factory direct personnel shall provide startup and training only. The use of agents, manufacturer's representatives, associated integrators or manufacturer's distributors for startup and training shall not be permitted.

3.03 SPARE PARTS

A. A complete set of Spare Parts shall be included. Spare parts shall include, but not be limited to:

1. One each of each type of Printed Circuit Board.
2. One of each type and size of control fuse.
3. Three of each type and size of power fuse.
4. One complete spare Power Cell of each type and size used.

END OF SECTION 16486

SECTION 16489
LARGE VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SCOPE

A. Description: This Section specifies 480 volt, 3-phase, low voltage variable frequency drive (VFD) systems, to operate in conjunction with submersible type centrifugal pump induction motors. Each VFD system shall use pulse width modulated (PWM) technology. The VFD system shall include phase-shift isolation transformers, harmonic filters, input converter unit, output inverter unit, output filter unit, control circuitry, protective equipment, interconnecting cabling and other accessories required to provide the specified functions. The VFD assembly shall be suitable for front access and top and bottom conduit entry.

B. The variable frequency drives specified in this section shall be furnished by the manufacturer of the submersible pumps specified in Section 11199.

C. Type: The PWM variable frequency drive shall be 480 volt, 3-phase. The drive shall be a minimum 18-pulse design.

D. VFD Schedule: See the Contract Drawings for equipment quantities and numbers.

E. Design Requirements: The drive shall meet the following requirements:

1. Minimum VFD efficiency shall be 97 percent at 100 percent speed and 100 percent torque.
2. The VFD shall operate within the specified limits with input voltage 480 volt plus 10 percent to minus 10 percent; frequency 57 to 63 Hertz.
3. Service factor of 1.15 based upon the nominal rating of the drive.
4. The VFD shall satisfactorily operate at an ambient temperature rating from 0 to 40 degrees C, and at maximum humidity of 95 percent.
5. The unit shall operate without overload over the full operating range specified.
6. Based on the available fault current on the input side, the VFD supplier shall verify the VFD can withstand the corresponding fault current and ground fault on the output side.
7. The VFD shall be capable of operating a motor load with a minimum speed range of 30 to 66 Hz.
8. The VFD shall be capable of providing breakaway torque for the load.
9. The VFD shall be capable of operation up to a maximum of 66 Hz.
10. The elevation shall be about 827 feet above MSL.
11. The power unit ranging basis shall be 100 percent rated current continuous.
12. Displacement power factor shall be 95 percent or higher throughout the entire operating speed range, measured at drive terminals.
13. Copper bus shall be braced for 85,000 amperes minimum.

14. Each VFD shall have molded case, circuit breaker type main power disconnect switch with an external operating handle. The circuit breaker shall have minimum short circuit rating of 85,000 amperes RMS symmetrical interrupting capacity and meet UL 489 requirements.

15. All drives shall be furnished by the same manufacturer.

16. The VFD shall comply with the latest applicable standards of American National Standard Institute (ANSI), National Electrical Manufacturers Association (NEMA), Institute of Electrical and Electronics Engineers (IEEE), and the latest edition of the National Electrical Code (NEC).

17. The supplier of the VFD shall coordinate with the mechanical equipment supplier for any technical data or information necessary to design the VFD for its appropriate function. To meet the specification requirements, coordinate with the Engineer.

1.02 SUBMITTALS

A. The following information shall be provided in accordance with the General Conditions and the requirements of Division 1:

1. Certificate of Unit Responsibility attesting that the supplier has assigned unit responsibility in accordance with the requirements of this Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with these requirements.

2. A copy of this Specification Section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate Specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the Specifications are indicated and, therefore requested by the supplier, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph. The remaining portions of the paragraph not underlined will signify compliance on the part of the supplier with the Specifications. The submittal shall be accompanied by detailed, written justification for each deviation. Failure to include a copy of the marked up Specification Sections, along with justification(s) for any requested deviations to the Specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

3. Suppliers product literature, technical data, and instructions and start-up manuals.

4. Test setup and testing procedure as specified in paragraph 1.03 B.

5. Shop drawings shall include front panel layout and dimensions of the equipment, recommended equipment foundation, anchorage and support, shipping section dimensions, weight, and conduit entrances.

6. Control schematic showing internal wiring connection diagrams, external interconnection wiring drawings showing the function, and identification of all terminals requiring field connections.

7. Continuous and fault ratings of drive and disconnecting means.

8. Calculation of VFD efficiencies at 50, 75, and 100 percent speed.

9. Suppliers certification acknowledging that the supplier will submit detailed schematics, parts list, and diagnostic information for their equipment, as required per Section 01730.

10. Harmonic analysis and the harmonic distortion calculations, per paragraph 1.03 B. The analysis shall be accompanied with a report summarizing the harmonic calculation program used, a tabulation of the data used in the study, a list of assumptions with valid justifications for the assumptions, and a statement of the results that the filter designed shall meet the specified system requirement. The report shall be signed and sealed by a Registered Professional Electrical Engineer.

11. Component fabrication drawings consisting of layouts for all electrical and electronic components. In addition, these will include the technical data, suppliers name and catalog sheets for all prefabricated cables, raceways, etc., that need to be assembled at site.

12. Proprietary factory test setup and testing procedure shall be presented verbally to confirm compliance with paragraph 1.03 B.

13. Each page of the individual submittal shall be identified with the item/equipment number provided in paragraph 1.01 E.

1.03 QUALITY ASSURANCE

A. References: This section contains references to the following documents. They are a part of this section as specified and modified. The latest edition of the referenced documents, at the time of bidding, shall be applicable. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1. ANSI/IEEE 519-92, Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

2. NEMA ICS 6-88, Enclosures for Industrial Control and Systems.

3. NFPA 70-, Current Editions of the National Electrical Code (NEC) as adopted by the City of Atlanta.

B. Factory Tests: The factory tests for all components shall be conducted in accordance with the requirements of the Testing Section and also as specified in this section.

1. All components shall be 100 percent tested. All components including printed circuit boards shall be burned-in continuously for 96 hours at 60 degrees C. The printed circuit boards shall be tested throughout the burn-in to ensure they are functioning within specification. Every thyristor shall have the following critical parameters tested at rated current: gating, turn-on, turn-off, high temperature, forward blocking, reverse blocking and waveform characteristics. All assembled phase cells shall be tested for cell balance at rated voltage, maximum current, maximum dV/dT and maximum dI/dT.

2. Control power shall be applied to microprocessors, printed circuit boards, diagnostic boards and similar devices including software to test for proper operation, sequencing, logic and diagnostics.

3. All wiring shall be checked for continuity and for compliance with the wiring diagrams.

4. The VFD supplier shall provide certification that these factory tests have been completed.

5. Harmonic analysis shall be performed for the drive at unit full load using a harmonic analyzer by Hewlett Packard, or equal. Results shall be corrected for a source impedance (available from the Engineer) delineated in terms of noncontributing short circuit amps listed below and shall be listed in a report. Tests shall prove that sufficient filtering has been

provided to limit the total harmonic distortion to a magnitude of 3 percent of the fundamental. The report shall include the following:

a. Expected harmonic components through the 99th harmonic, calculated with and without harmonic filtering.

b. RMS value of total harmonic distortion (THD) expected.

c. The total harmonic distortion for voltage and current, at the point of common coupling (PCC) shall meet the requirements of the latest edition of IEEE 519, and the requirements of this Specification.

d. The PCC shall be defined as the low voltage bus feeding the drive motors and other loads. This point shall be used for all harmonic analysis calculations and field measurements for both voltage and current harmonic distortions. For the location of PCC, see the applicable low voltage switchgear one-line diagram.

e. The results of the harmonic analysis calculation shall be submitted per paragraph 1.02.

C. Unit Responsibility: The supplier shall have the unit responsibility for the proper functioning of the VFD in conjunction with the pump motor.

1.04 SHIPMENT HANDLING AND STORAGE

A. General: Equipment, products and, materials shall be shipped, handled, stored, and installed in ways which will prevent damage to the items. Damaged items will not be permitted as part of the work except in cases of minor damage that have been satisfactorily repaired and are acceptable to the Engineer.

B. Package and Marking: All equipment shall be protected against damage from moisture, handling, or other cause during transport from suppliers premises to site. Each item or package shall be marked with the number unique to the specification reference covering the item.

C. Stiffeners shall be used where necessary to maintain shapes and to give rigidity. Parts of equipment shall be delivered in assembled or sub-assembled units where possible.

D. Identification: Each item of equipment shall have permanently affixed to it a label or tag with its equipment number designated in this contract. Marker shall be of stainless steel. Location of label shall be easily visible.

E. Shipping: Vents and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt. Damage shall be corrected to conform to the requirements of the contract before the assembly is incorporated into the work. The supplier shall bear the costs arising out of dismantling, inspecting, repair and reassembly.

F. Storage: During the interval between the delivery of equipment to the site and installation, all equipment, unless otherwise specified, shall be stored by the Contractor in an enclosed space affording protection from weather, dust and mechanical damage and providing favorable temperature, humidity and ventilation conditions to ensure against equipment deterioration. Suppliers' recommendations shall be adhered to in addition to these requirements.

PART 2 - PRODUCTS

2.01 ACCEPTABLE PRODUCTS

A. Drive shall be Allen Bradley, Cutler-Hammer, Square D, or equal, to provide the specified features and to meet the specified design requirements.

2.02 ENCLOSURE

A. The enclosure shall be a dead-front, freestanding assembly. Working height shall be not greater than 90 inches. Doors shall be 12 gauge sheet steel with pin type hinges. The doors shall be no wider than 44 inches and shall be key lockable. A continuous bare copper ground bus (1/4 inch by 1 inch) shall be provided along the entire length of the enclosure. Removable lifting angles shall be provided.

B. All sections involving operator control switches, handles, disconnects, or monitoring instruments, and indicators shall be front panel mounted.

C. Unless otherwise specified, the enclosure shall be NEMA 1. Enclosure shall be suitable for either top or bottom cable entry and front access only.

D. Enclosure shall be treated with zinc phosphate, bonderized or otherwise given a rust-preventive treatment. Equipment shall be printed, painted with enamel, and baked. Minimum dry film thickness shall be 3 mils. The exterior color of the enclosure shall be ANSI 49 gray.

E. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation an equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible location with stainless screws or drive pins.

2.03 VFD SYSTEM COMPONENTS

A. Design Feature: The VFD shall include converter, indicator, inverter, DC link, and low voltage sections. These sections shall be grouped into separate sections with each section modularized for ease of troubleshooting. All Silicon Control Rectifiers (SCRs) used in the converter and inverter sections shall be standard rectifier grade devices containing the SCR suppliers standard catalog numbers such that they can be readily cross-referenced and interchanged with other SCR suppliers devices. SCR catalog numbers must be submitted as part of the submittal package. No fast switching SCRs will be allowed. The highlights of the VFD design features are addressed below:

1. The converter section shall be a full wave, phase controlled, three-phase converter to change input AC power to DC power.
2. The output of the converter shall feed an inductor and the converter/inductor combination shall form a current source whose output is regulated and limited. The current limit feature of the converter shall be sufficiently fast and effective so as to protect against a sudden and/or random application of a short circuit to the output terminals of the current source.
3. The inverter section shall convert the DC power of the current source to adjustable frequency power to the motor. The VFD shall not induce excessive power losses in the motor. The worst case Root-Mean-Square (RMS) motor line current measured at rated

speed, torque, and voltage shall not exceed the rated RMS motor current for pure sine wave operation.

4. The VFD supplier shall provide the necessary design and filtering required to meet the harmonic requirements of latest edition of IEEE 519, and as specified. A preliminary harmonic analysis shall be provided prior to design. Total harmonic distortion reflected back into the system shall be limited to 3 percent.

B. Accessories: The AC power units shall be enclosed in a sheet metal housing of NEMA1 construction requiring front access only. VFDs requiring rear access for any maintenance are not acceptable. VFD shall be constructed with air-cooled SCR assemblies and inductors for a minimum amount of complexity and highest reliability. VFDs using liquid-cooled assemblies in conjunction with associated pumps, piping, and separate remote mounted heat exchangers are not acceptable. The following accessories shall be provided:

1. Input disconnect switch handle interlocked with power unit door.
2. One three-position mode selector switch marked "HAND-OFF-AUTOMATIC."
3. One "Power On" light.
4. One VFD emergency stop reset pushbutton for remote reset.
5. Input MOV surge arrestors for surge protection.
6. The drive shall include 100 percent capacity cooling fans.
7. One two-position selector switch marked "LOCAL-REMOTE".
8. One "Run" light.
9. One "Off" light.
10. One "Fail" light.
11. All pilot lights shall be push-to-test.

C. Output Contractor: Furnish and install an output contractor.

2.04 CONTROL, MONITORING, ANNUNCIATION AND PROTECTIVE FEATURES

A. The VFDs shall include the following except where specified alternative controls are indicated on the Project Piping & Instrument Diagrams and/or pump control descriptions.

1. With the "HAND-OFF-AUTOMATIC" switch in the "HAND" position, the drive shall operate at a predefined speed.
2. With the "HAND-OFF-AUTOMATIC" switch in the "AUTOMATIC" position, the drive shall operate when directed by a remote signal.
3. With the "LOCAL-REMOTE" switch in the "LOCAL" position, the output speed shall be controlled by the VFD furnished panel.
4. With the "LOCAL-REMOTE" switch in the "REMOTE" position, the output speed shall be controlled by a 4-20 mA demand signal from remote.
5. The VFD shall shut down on high motor winding temperature, high motor bearing temperature where applicable.

6. VFD run status, failure status, and speed shall be provided for remote indication.
7. Optical isolation shall be provided to accept the grounded or ungrounded 4-20 mA input demand signal.
8. Manual remote or local restart after drive trip or utility failure, upon remote or local reset.
9. Speed profile: Individual adjustable settings for start, stop, acceleration and deceleration rates, and minimum and maximum speed points.
10. Process signal inverter: Software selectable to allow speed of drive to vary inversely with input signal.
11. A door-mounted digital keypad/display unit shall be provided and capable of controlling the VFD and setting drive parameters.
12. The digital display shall normally display:
    a. Speed demand in percent
    b. Output current in amperes
    c. Frequency in hertz
    d. Control Mode: local/remote
    e. Total three-phase kW
13. The keypad will display diagnostic messages and parameter values when accessed.
14. The digital keypad/terminal shall allow operations to enter exact numerical settings in English engineering units. A user menu is to be provided as a guide to parameter setting. Coded messages on the keypad will not be acceptable. Drive parameters are to be factory set in EEPROM and resettable in the field through the keypad. One level of password security shall be available to protect drive parameters from unauthorized personnel. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.
15. The keypad/display shall have a key switch to control operation of the keypad. Key to be removable in either "ENABLED" or "DISABLED" positions. Keypad module shall contain a "self-test" software program that can be activated to verify proper keypad operations.
16. The controller shall have the following adjustments available, accessible through a keypad display unit or serial communication links:
    a. Speed: Frequency-Max., Frequency-Min.
    b. Independent acceleration/deceleration rates: 4 to 300 seconds.
    c. Voltage Parameters: V-min., V-max. Current Limit: 5 to 110 percent of drive rating.
    d. Inverse time overload, limit, time.
    e. Current Boost.
    f. Speed shedding current limit.
    g. Speed Profile: Entry, Exit, Min. Speed, Max. Speed.
    h. Inverse Profile
    i. Selectable follower/set point control.
17. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the current set values. This parameter log shall be accessible via an RS232 serial port as well as on the keypad display.
18. The converter shall be protected against internal faults.

19. The power circuit design shall be such that the following fault conditions can occur without damage to the power circuit components:
    a. Single phase fault or three-phase short circuit on VFD output terminals.
    b. Failure to commutate inverter SCR due to severe overload or other conditions.
    c. Loss of input power due to opening of VFD input or utility power failure during VFD operation.
    d. Loss of one (1) phase of input power.
    e. VFD shall be protected against open circuit conditions on output of VFD. If an open circuit occurs, VFD shall automatically shut down in an orderly fashion without component failures.
20. To ensure safety and reliability of the equipment, the VFD shall include these features:
    a. Static instantaneous overcurrent and overvoltage trip, with adjustable voltage, current, and time.
    b. Static overspeed (overfrequency) protection.
    c. Phase sequence detector, line fuse loss, and undervoltage protection, with adjustable voltage and time.
    d. Motor inverse time overload protection; device separate from electronic protective function.
    e. Printed circuit boards shall include a solder mask and a clear varnish coating for corrosion protection.
    f. All bus shall be tin plated copper or all conductors shall be copper.
21. Control power transformer with 120VAC secondary, two primary and one secondary fuse and 200 VA additional capacity for external devices.
22. Provide start inhibit timer. Agastat or equal, 1-10 minute adjustable time.
23. Provide jam protection consisting of CT with ground fault relay or equal.

2.05 VFD FAULT INITIATION, TEST FEATURES, AND MONITORS

A. Fault Initiation: The following fault conditions shall cause an orderly drive shutdown:

1. Loss of input power.
2. Undervoltage.
3. Sustained gradual overload.
4. Instantaneous severe overload.
5. SCR overtemperature.
6. Overvoltage.
7. Blown fuse.
8. Logic power supply failure.
9. Restart shall be manually initiated (either local or remote) upon local or remote reset. Two unsuccessful restart attempts shall result in permanent shutdown and alarm.

B. Test Features: The VFD shall have the following test feature:

1. Lights on each converter and inverter SCR and inverter diodes to indicate an SCR or diode failure.
2. SCR gate pulse lights to provide diagnostic checks as follows:
   a. Lights to indicate the presence of gate pulses on each converter SCR.
   b. Lights to indicate the presence of gate pulses on each inverter IGBT.
3. Test meter or display/terminal with switch to test for the following control signals:
   a. Frequency command.
   b. Voltage command.
   c. Motor voltage feedback.
   d. Inverter bus voltage.
   e. Current command.
   f. Current feedback.
   g. Converter command.
   h. Filtered inverter bus voltage.
4. Test modes as follows:
   a. The gating test mode shall ensure that proper gating is taking place.
   b. Open Circuit Test – with VFD in this position, VFD shall be capable of operation with no motor load connected. This is to verify correct VFD operation.

C. Monitors: The following monitoring features shall be provided:

1. The VFD shall include a comprehensive microprocessor-based digital diagnostic system which monitors its own control functions and displays faults and operating conditions.

2.06 VFD AND MOTOR PROTECTION INTERFACE

A. VFD shall interface with pump monitor supplied by the pump manufacturer. This monitor shall provide pump protection for moisture and temperature. Also, where indicated on the Piping & Instrument Diagrams, provide interface relay, control etc., as required for pump vibration.

2.07 SPARE PARTS

A. Spare parts shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified as to part number, equipment manufacturer, and subassembly component (if appropriate). Spare parts subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping. Spare parts with individual weights less than 50 pounds and dimensions less than 2 feet wide, or 18 inches high or 3 feet in length shall be stored in a wooden box with a hinged wooden cover and locking hasp. Hinges shall be strap type. The box shall be painted and identified with stenciled lettering stating the name of the equipment, equipment numbers, and the words "spare parts". A neatly typed inventory of spare parts shall be taped to the underside of the cover. The following spare parts shall be provided for the sizes and types furnished in the equipment:

2 – each printed circuit board type of each type furnished in the equipment, and, 1 card extender of each type

2 – each relay type

1 – inverter IGBT assembly (+bus)

1 – inverter IGBT assembly (-bus)

1 – converter assembly

2 – sets of each size and type of power and control fuses

3 – spare light bulbs of each type and size provided in the equipment

1 – set of all special tools required for normal operation and maintenance

2.08 PRODUCT DATA

A. The following information shall be provided in accordance with Division 1:

1. Applicable operation and maintenance information as specified. Operation and maintenance (O&M) instructions. Provide each paragraph check-marked to show compliance. O&M instructions shall be submitted after all submittals have been approved. The O&M instructions shall reflect the approved materials and equipment.
2. Certification of completion of load, heat, harmonic tests, and harmonic analysis calculations, as specified in paragraph 1.02.
3. Suppliers product literature.
4. Suppliers certification that drive can withstand fault conditions specified in paragraph 16489-1.01 E.
5. Installation certification as specified in paragraph 3.02.
6. Testing procedures and forms as specified in 3.03.
7. Training certification form as specified in paragraph 3.04.
8. Factory testing results, specified in paragraph 3.01 B.

2.09 LABELING

A. Each control panel or cabinet shall be provided with exterior nameplate that identifies the panel in accordance with the panel name and description as shown on the Contract Drawings. Nameplates shall be at least 1-inch high x 3-inch wide constructed of plastic laminate that is at least 1/16 inch (1.6 mm) thickness for nameplates up to 20 square inch (129 square cm) or at least 1/8 inch thick (3.2 mm) for larger sizes. Nameplate shall be engraved using a "sans serif" type font like Arial or Helvetica typefaces. Lettering shall be approximately ¼" in height, consisting of White Lettering on a Black background. Nameplates shall be beveled and attached to panels by self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers. Nameplates that are only adhesive bonded or glued to the panel or cabinet shall not be accepted.

B. Additionally each control panel or cabinet shall be provided with nameplates identifying each component, selector switches, pilot lights, and all internal components and etc. Nameplates shall be laminated plastic, engraved white letters with a black background. Nameplates shall be mounted adjacent to but not on each component. Nameplates shall be permanently affixed with stainless steel self-tapping screws.

C. Where applicable, also provide a nameplate, which reads as follows "CAUTION - THIS PANEL CONTAINS A VOLTAGE FROM AN EXTERNAL SOURCE." Engraving shall be approximately 3/16" in height, consisting of black lettering on a high visibility yellow background. Nameplates shall be beveled and attached to panels by self-tapping stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers. Adhesive bonded or glued on nameplates shall not be accepted.

2.10 NETWORKING

A. VFD shall be ModBus compatible. Connect to PLC, pump monitoring panels, and local control panels.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The supplier shall perform the factory testing for all equipment, including the items specified in paragraph 16489-1.03 B., in accordance with Section 01660. All tests shall comply with the latest versions of IEEE, UL, NEMA, and other applicable standards. The test results shall be submitted per paragraph 16489-2.08.

3.02 INSTALLATION

A. The equipment shall be installed and tested under the direction of factory-trained personnel. The installation shall meet all the requirements of the latest edition of the National Electrical Code (NFPA 70). The installation shall be certified.

B. Furnish and install a 4" high concrete housekeeping pad beneath each drive.

3.03 FIELD TESTING

A. General: The field testing certificate shall be submitted by the supplier. The testing procedure and forms shall be provided.

B. Field tests of the drive shall be made by the drive supplier who will furnish all equipment and record all data. The Contractor shall be present during testing. Field tests are the basis of demonstrating equipment proficiency and correct operation.

C. If the drive performance does not meet the specifications, corrective measures shall be taken to satisfy the conditions specified. A seven (7) day (actual operation) operating period of the drive will be required before acceptance. If a drive fails to perform and must be replaced, the rejected drive shall not be removed until the replacement drive has been delivered to the site. The Owner shall be allowed to use any drive supplied immediately following installation and testing whether or not the pump meets the conditions specified.

D. The drive supplier shall test the drive controller similar to the existing motor load prior to shipment.

3.04 TRAINING

A. On-Site Training: On-site training shall be scheduled through the Contractor with the Owner. A minimum of 16 hours of training shall be provided for on-site training. A maintenance training class shall be presented at two different times. All training shall be certified. All travel cost for the training shall be furnished by the Contractor.

B. Training will not be permitted until all equipment is fully operational. In the event that the equipment becomes inoperable under warranty provisions, additional on-site training will be provided at no additional cost to the Owner as follows:

Inoperable Period	Additional Training
0 – 2 weeks	None
2 – 6 weeks	8 hours
More than 6 weeks	16 hours

END OF SECTION 16489

SECTION 16510
LIGHTING FIXTURES

PART 1 - GENERAL

1.01 SCOPE

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of lighting fixtures, including luminaries and accessories, lamps and ballasts. All fixtures shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Product data including dimensions, accessories, installation and construction details and photometric data.
2. Complete data, including computer printouts showing maintained luminance values using a 0.81 M.F.

1.03 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electrical Code.

1.04 QUALITY STANDARDS

A. The products covered by these Specifications shall be in conformance with the latest edition of the NFPA to (NEC).

B. Manufacturers offering products that comply with these specifications include:

1. Fixtures: As specified on the lighting fixture specification sheet.
2. Lamps: General Electric, Sylvania, Phillips Lighting, or equal.
3. Ballasts: General Electric, Advance, Universal, Holophane or equal.

1.05 WARRANTY

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 LUMINAIRES AND ACCESSORIES

A. Provide fixtures as specified on the Lighting Fixture Specification sheets. Lighting Fixture Specification sheets are attached to the end of this Section of the Specifications.

B. Where flat acrylic lenses are specified in fluorescent fixtures, use 100% virgin acrylic, pattern 12 0.125-inch thickness.

C. Provide fixture housings and frames to match the ceilings called for on the architectural drawings.

D. Provide a conduit backpan for surface mounted fixtures, wall or ceiling, where surface mounted conduit is used.

E. HID Luminaries: Pre-wired, with integral ballast.

2.02 LAMPS

A. General Use Incandescent Lamps: Inside frosted type, rated 130 volts.

B. Incandescent Reflector Lamps: Shape as scheduled, rated 130 volts.

C. Fluorescent Lamps: Cool white, all by same manufacturer.

D. High Pressure Sodium Lamps: Clear, suitable for all burning positions.

2.03 FLUORESCENT BALLASTS

A. Provide high power factor type ballasts (unless otherwise indicated) conforming to UL 935, ANSI C82.1 standards; labeled by certified ballast manufacturers (CBM); certified by Electrical Testing Laboratories (ETL).

B. Provide Class P ballast with sound rating "A" (unless otherwise noted).

C. Furnish 0 degrees F ballast for exterior luminaries.

D. Coordinate ballast-operating voltage with supply voltage as shown on drawings.

2.04 HID BALLASTS

A. Provide single-lamp, high power factor type, constant wattage autotransformer (CWA) or regulator ballast (unless otherwise indicated) conforming to UL 1029 and ANSI C82.4 standards.

B. Temperature: reliable starting to minus 20 degrees C, designed for normal operation in ambient 40 degrees C.

C. Use ballasts constructed so that open circuit operation will not reduce the average life.

D. Provide High Pressure Sodium (HPS) ballasts with a solid-state igniter/starter with an average life in the pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 degrees C.

2.05 LIGHTING CONTROL

A. Provide electrically held contactors with 120 VAC operating coils, and 20 amp contacts. Provide controller and contactor in common NEMA 1 enclosure. Number of contacts as required.

B. Acceptable Manufacturers

1. Contactor-Equal to ASCO, Square D, or General Electric

2.06 SITE JUNCTION BOXES

A. Junction boxes for the distribution of outdoor lighting circuits shall be precast concrete, set flush with the ground. Size shall be approximately 10.5" x 17.25" x 12" inches deep. Lid shall be cast iron with cast inscription: STREET LIGHTING". Boxes shall be Brooks Products, Christy Concrete Products, Forni Corporation, Utility Vault Company, or equal.

2.07 PHOTOELECTRIC CELL UNITS

A. Photoelectric cell units shall consist of a cadmium sulfide cell housed in a plug receptacle assembly. The plug receptacle assembly shall be three-prong polarized locking type. Assembly shall be suitable for outdoor mounting and shall be rated for 1800 VA at 120V maximum capacity.

2.08 POLES

A. Light poles shall be as specified in the electrical standard detail and light fixture schedule,E0-601.

2.09 LED LOW BAY LUMINAIRES

A. The LED Low Bay Luminaire shall be MADE IN AMERICA.

B. Physical and Mechanical Requirements

1. Physical Dimensions
   a. Nominal Fixture size as installed: 19.7" X 16" X 5.5"
2. Mechanical
   a. Mounting Method to allow for direct mount to a standard 4" ceiling electrical box, a hanging ¾" pendent or via six knock out holes for surface mounting.
   b. Mounting bracket to be an integral part of the Luminaire fixture and fully removable from the main lighting housing to allow for easy mounting of bracket assembly and electrical connections prior to main lighting housing attachment.
   c. Mounting bracket to have inverted "T' slots to allow the main lighting housing to hang freely during electrical installation and hook up.

d. The fixture shall utilize modular components that fully field replaceable without the need of special tools. The LED module shall be a self-contained unit and have a M12 screw in electrical connection to allow easy disconnect.

3. Materials
   a. All metal housing/bracket materials used shall be weather resistant either Aluminum or Stainless Steel.
   b. Metal coating shall be a high quality thermal baked dry spray powder material.
   c. All hardware to be stainless steel.
   d. Materials used for the module lens and LED module construction shall conform to ASTM specifications where applicable.
   e. Lens shall use UV stabilized material.
   f. Enclosures containing the power supply and electronic components of the LED module shall be made of UL94VO flame retardant material.
   g. All electrical wires and connectors to meet UL standards.
   h. Installation requirements: Installation of an LED fixture into existing pole/mast arm shall only require the removal of the existing light fixture and shall connect directly to existing electrical wiring. Installation shall not require special tools.
   i. The module shall provide Type 2 or Type 3 radiation pattern as required and must meet minimum roadway surface candela requirements as per IES national roadway standard.

C. Environmental Requirements

1. The LED fixture shall be rated for use in the ambient operating temperature range of -30°C to 70°C.
2. The LED fixture shall be protected against dust and moisture intrusion as per NEMA standard 250-1991 type 4 meeting an IP67 classification.
3. The fixture shall be certified as a wet location fixture.
4. Nominal temperature for all specification compliance measurements is 22°C +/- 3°C.
5. The lens surface shall be generally smooth on the outside to reduce dust and dirt collection. There shall be no diffused, Fresnel or rough surfaces.

D. Module Identification

1. Each LED light fixture shall be identified with the manufacturer's name and serial number clearly showing date of manufacture.
2. The following operating characteristics shall be identified: nominal operating voltage, power consumption and Volt-Ampere.
3. The LED fixture shall clearly show a safety compliance listing mark.
4. The LED module shall clearly show a UL listing mark.
5. The Power supply shall clearly show a UL listing mark.
6. The fixture shall clearly show marking indicating MADE IN AMERICA.

E. Photometric Requirements

1. Photometric measurement shall be documented by an independent test lab report according to IESNA specification.
2. All certified independent test lab reports shall include IES format file for use with lighting software.
3. The standard chromaticity color for the LED light fixture shall be cool white.
4. The color temperature shall be typical 6200°K +/- 500°K.
5. The Color Rendering Index (CRI) shall be 75 +/- 3.
6. The fixture shall have a minimum lumen efficiency of 70lm/W.
7. Each individual LED module shall have a minimum output of 2000 lumens.
8. The LED fixture as properly installed in intended application shall meet the minimum lighting levels as indicated in the IESNA publication RP-20-98, "Lighting for Parking Facilities".

F. Electrical

1. The fixture shall be certified to meet standards UL 1598, UL 8750, CSA 22.2 #250.0.08 standards. Certification to be via a qualified 3rd party testing laboratory, Intertek, UL or other.
2. LED light fixture shall operate from a 50-60 Hertz AC line power over a voltage range from 90 VAC RMS to 277 VAC RMS.
3. Nominal operating voltage for all specification compliance measurements shall be 120+/- 3 VAC RMS.
4. Fluctuation in the line over the voltage range shall not affect luminous intensity by more than +/- 10%.
5. Fixture power supply shall be UL approved with a class 2 rating.
6. Transient Voltage Protection: The LED fixture and the on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as stated in section 2.1.6, NEMA Standard TS-2, 1992.
7. EMC Noise
   a. The LED fixture and the on-board circuitry must meet Federal Communications Commission (FCC) Title 47, subpart B, section 15 regulations concerning the emission of electronic noise.
8. Power Factor (PF) and AC Harmonics
   a. LED light fixture shall provide a power factor of .9 or greater.
   b. Total Harmonic distortion shall be less than 20%.

9. Power Consumption
   a. Typical power consumption for each fixture shall be as follows;

1 LED Module	28 watts
2 LED Module	56 watts
3 LED Module	84 watts

2.10 LED WALL PACK LUMINAIRE

A. The LED Wall Pack Luminaire shall be MADE IN AMERICA.

B. Physical and Mechanical Requirements

1. Physical Dimensions
   a. Nominal Fixture size as installed: 9" X 13" X 7.75"
2. Mechanical
   a. Mounting method shall provide the option for direct mount to an industry standard 4" electrical box or via knock out holes for surface mounting.
   b. The fixture shall utilize modular components that are fully field replaceable without the need of special tools. The LED module shall be a self-contained unit and have a M12 screw-in electrical connection to allow easy disconnect.
   c. Modular components at a minimum shall be; LED modules, Power Supply, Interconnecting cable assemblies, power cord.
3. Materials
   a. All metal housing/bracket materials used shall be weather resistant either Aluminum or Stainless Steel.
   b. Metal coating shall be a high quality thermal baked dry spray powder material.
   c. All hardware to be stainless steel.
   d. Materials used for the module lens and LED module construction shall conform to ASTM specifications where applicable.
   e. Lens shall use UV stabilized material.
   f. Enclosures containing the power supply and electronic components of the LED module shall be made of UL94VO flame retardant material.
   g. All electrical wires and connectors to meet UL standards.

C. Environmental Requirements

1. The LED fixture shall be rated for use in the ambient operating temperature range of -30°C to 70°C.
2. The LED fixture and contained modular components shall be protected against dust and moisture intrusion as per NEMA standard 250-1991 type 4 meeting a wet listing classification.
3. The luminaire fixture shall be certified as a wet location fixture.
4. Nominal temperature for all specification compliance measurements is 22°C +/- 3°C.

5. The lens surface shall be generally smooth on the outside to reduce dust and dirt collection. There shall be no diffused, Fresnel or rough surfaces.

D. Module Identification

1. Each LED light fixture shall be identified with the manufacturer's name, model number, serial number and clearly showing date of manufacture.
2. The following operating characteristics shall be identified: nominal operating voltage, power consumption and Volt-Ampere.
3. The LED fixture shall clearly show a safety compliance listing mark with regulatory file number.
4. The LED module shall clearly show a UL listing mark.
5. The Power supply shall clearly show a UL listing mark.
6. The fixture shall clearly show marking indicating MADE IN AMERICA.
7. The fixture shall clearly show "SUITABLE FOR WET LOCATION".

E. Photometric Requirements

1. Photometric measurement shall be documented by an independent test lab report according to IESNA specification.
2. All certified independent test lab reports shall include IES format file for use with lighting software.
3. The standard chromaticity color for the LED light fixture shall be cool white.
4. LEDs shall be either Cree®, Lumiled® or Nichia® industry standard product.
5. IES L70 lumen depreciation level to be a minimum of 120,000 hrs at 55°C.
6. The color temperature shall be typical 6200°K +/- 500°K.
7. The Color Rendering Index (CRI) shall be 75 +/- 3.
8. The fixture shall have a minimum lumen efficiency of 74lm/W.
9. Each individual LED module shall have a minimum output of 2000 lumens, total fixture lumen shall equate to the number of modules times the minimum lumen per each module.

F. Electrical

1. The LED luminaire fixture shall be certified to meet standards UL 1598, UL 8750, CSA 22.2 #250.0.08 standards. Certification to be via a qualified 3rd party testing laboratory, I.e., Intertek, UL or other. Fixture shall be clearly marked with listing file number.
2. The individual LED Lighting Module Brick shall have a UL listing to UL 1598, UL 8750 and shall be clearly mark with UL listing file number.
3. LED light fixture shall operate from a 50-60 Hertz AC line power over a voltage range from 90 VAC RMS to 277 VAC RMS.
4. Nominal operating voltage for all specification compliance measurements shall be 120+/- 3 VAC RMS.

5. Fluctuation in the line over the voltage range shall not affect luminous intensity by more than +/- 10%.

6. Fixture power supply shall be UL approved with a class 2 rating.

7. Transient Voltage Protection: The LED fixture and the on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as stated in section 2.1.6, NEMA Standard TS-2, 1992.

8. EMC Noise: The LED fixture and the on-board circuitry must meet Federal Communications Commission (FCC) Title 47, subpart B, section 15 regulations concerning the emission of electronic noise.

9. Power Factor (PF) and AC Harmonics
   a. LED light fixture shall have a power factor of 0.9 or greater.
   b. Total Harmonic distortion shall be less than 20%.

10. Power Consumption
    a. Typical power consumption for each fixture shall be as follows;

1 LED Module	28 watts
2 LED Module	56 watts

2.11 LIGHTING CONTROL CENTER

A. Provide a 365-day digital microprocessor based on solid-state time control center suitable for use with electrically held contactor. Controller shall switch lights "ON" at sunset and "OFF" at sunrise. Units shall automatically adjust for length of daylight hours.

B. Control shall provide an additional "ON" and "OFF" event as well as selectable daylight savings time adjustment and automatic leap year correction. Control shall have a Skip-A-Day, Offset to Sunrise and/or sunset and Manual Override. Control shall have adjustable latitude from 10 degrees to 70 degrees northern or southern hemisphere and selectable 12 or 24-hour clock format. Control shall have 275 hours of carry-over with a lithium battery.

C. The control shall switch 15 amps at 120VAC, resistive or inductive, on each pole of the DPDT outlets.

D. Provide electrically held or electronically held contactor as indicated with 120VAC operating coils, 4 poles, and 20 amp contacts. Provide controller and contactor in common NEMA 1 enclosure. See drawing E0-601

E. Acceptable Manufacturers

1. Time Controller - Paragon, Tork or equal.
2. Contactor - ASCO, Square D, General Electric or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lamps in luminaries and lamp holders.

B. Install fixtures to center or replace acoustical tile sections. Support fixtures from the building structure through the use of the ceiling support system, where the ceiling support system is designed for the lighting fixture's weight. Fluorescent lighting fixtures installed in exposed ceiling grid ceilings: provide two (2) "safety clips" or "safety hooks" for securing fixture to ceiling grid, and located at opposite corners of fixture.

C. Where fluorescent fixtures are installed in exposed grid ceilings provide #14 gauge galvanized safety hanger wires which attach the fixture to the building structural system to prevent the fixture from falling due to movements in ceiling suspension channels. Attach the safety wire to fixture at a point other than where safety clips are attached.

D. Provide suspended fixtures with swivel hangers and threaded rod. For single-unit suspended fluorescent fixtures, provide twin suspension hangers.

E. Support surface lighting fixtures of more than ten pounds in weight with threaded rods from the building structure.

F. HID Luminaries: Use power hook hangers rated 500 pounds minimum or provide safety chain between ballast and structure. Provide safety chain between reflector and ballast.

G. Lighting plans show location, type and circuit number of lighting fixtures and receptacles only. Conduit and conductor shall be provided from the lighting fixtures, light switches and receptacles to the lighting panel in accordance with the NEC. Conduit and conductor shall be provided in accordance with Section 16111 and 16120.

H. Photoelectric cells shall be oriented toward the north.

3.02 RELAMPING

A. Relamp all burned out lamps upon completion of work.

3.03 ADJUSTING AND CLEANING

A. Clean lenses and diffusers at completion of Work. Clean paint splatters, dirt, and debris from installed luminaries.

B. Touch up luminaries at completion of work.

C. Mount continuous rows of luminaries in straight line. Utilize alignment clips between reflectors, where applicable.

3.04 LIGHTING FIXTURE SPECIFICATION SHEETS

A. Notes:

1. Lighting fixtures, including their related accessories, options, and hardware are specified on individual lighting specification sheets located at the end of this section.
2. The manufacturer's catalog numbers listed are examples of the basic model, or series, and the overall quality required. While the referenced catalog numbers attempt to be as definitive available literature permits, such items as voltage, mounting style, modifications,

and other special features may not be included. The Contractor, supplier, and manufacturer shall verify and provide all of the specified requirements.

3. Each lighting fixture specification sheet and lighting fixture type shown on the Drawings is identified with a unique acronym of two digits as follows:
   a. Lamp Sources: The first digit of the fixture type indicates the basic or predominant lamp source from which the light is produced, as follows:

      F=Fluorescent

      I=Incandescent

      M=Metal halide

   b. Family groups: The second digit of the fixture type indicates a family of fixtures, which share physical characteristics, such as appearance, construction or function. The family general requirements apply to all members of the family. All family members shall be produced by the same manufacturer and have matching characteristics. Family groups are as follows:

      C= Corrosion-resistant

      D= Downlight

      E= Emergency

      F= Floodlight

      I= Industrial

      V= Vaportight

      X= Exit sign

   c. Lighting fixtures specified in the lighting fixture specification sheet are alphabetically arranged by lamp source and function.

LIGHTING FIXTURE SPECIFICATION SHEET NO. 1

Family group	IB - Incandescent, Wall bracket
Group description	Surface, white opal glass.
Family members	IB1: Two 100-watt lamps. Six (6) inches high by 17 inches wide. Example: Prescolite No. WB-19
Construction	Finish: White, baked enamel base.
Lighting	Distribution: General, diffuse. Shieldinq: Formed white satin opal glass.
Lamps	Standard
Electrical	Input voltage: 120
Mounting	Surface on wall
Acceptable products	Halo, Lightolier, Marco, Prescolite, or equal.

LIGHTING FIXTURE SPECIFICATION SHEET NO. 2

Family group	IE - Incandescent, Emergency
Group description	Battery-powered emergency lighting unit. Corrosion resistant. 90-minute minimum light from integral batteries.
Family members	IE1: Power unit with batteries, power supply and charger and two lighting heads mounted on top. Example: Dual-Lite, No. 4 x 7-12V-TDR.
Lighting	Distribution: Adjustable light heads.
Lamps	25 watt, 12-volt sealed-beam incandescent, one per head.
Electrical	Input voltage: 120. Integral 12-volt transformer and battery charger.
Mounting	Power unit wall mounted in custom angle iron bracket assembly with bottom at +7-½ feet. See detail on Drawing.
Acceptable products	Chloride, Dual-Lite, Dyna-Ray, Exide, Holophane, Lithonia, Sure-Lites, or equal.

LIGHTING FIXTURE SPECIFICATION SHEET NO. 3

Family group	IX - Incandescent, Exit sign
Group description	IX1: Exit signs with 6 inch green letters. Directional arrows as shown. Oil, dust and corrosion resistant. Example: Dual-Lite N4X-ER-1-EP Dimensions: Approximately 9-½-inches high, 12-½-inches wide, universal snap on arrows.
Construction	Housing: Lightweight, unbreakable, injection molded, polycarbonate material. Finish: Poolycoated, aluminum backed stencil in white finish.
Lighting	Distribution: Light through red letters plus maximum down light.
Lamps	Two 15T6 ac lamps and two double contact bayonet base sockets with 3.6 watt.
Electrical	Input voltage: 120.
Mounting	Surface ceiling or wall mounting. See symbols on Drawing.
Acceptable products	Dual-Lite, Daybrite, McPhilben, Moldcaste or equal. Example: Dual-Lite No. N4X-ER-1-EP

LIGHTING FIXTURE SPECIFICATION SHEET NO. 5

Family group	FI - Fluorescent, Industrial
Group description	Bare lamp industrial with downlight reflector. Indoor use, nominally 1 foot wide by 4 feet long. Surface and pendent mounted.
Family members	FI1: Two lamps wide, 4 foot length.
Construction	Housing: Die-formed code gage steel housing. Finish: White, dry polyester powder finish over phosphate pretreatment.
Lighting	Distribution: General downlight. Reflector: Apertured, with 10 percent uplight. Shieldina: None.
Lamps	Standard grade: 32 watt
Electrical	Input voltage: 120. Ballasts: Ultrapremium grade, magnetic.
Mounting	Surface or pendent: ½-inch RSC threaded stems. Outlet boxes: Cast metal with threaded conduit entries. Ball aligners. See detail on Drawings.
Acceptable products	Day-Brite "CFI-10" series, or equal.

LIGHTING FIXTURE SPECIFICATION SHEET NO. 6

Family group	FC - Flourescent, Corrosion-resistant
Group description	Industrial indoor, enclosed surface and pendent, waterproof and chemical-resistant. Nominal 1 foot wide by 4 feet long.
Family members	FC1: Two 34-watt energy-saving T-12 lamps. FC3: same as FC1, plus integral emergency power supply.
Construction	Housing: Nonmetallic housing, injection molded, high-impact thermoplastic. Finish: Any interior metallic parts shall be stainless steel or zinc-phosphated steel painted with powder-coat white epoxy finish.
Lighting	Distribution: General downward. Shielding: Impact-resistant patterned acrylic diffuser.
Electrical	Input voltage: 120. Ballasts: Ultrapremium grade, magnetic.
Mounting	Surface or pendent stems.
Special	UL Damp Location label
Acceptable products	Day-Brite Vaporlume, Lithonia DL, Metalux VT, or equal.

END OF SECTION 16510

SECTION 16601
LIGHTNING PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes a complete UL Master Labeled Lightning Protection System for buildings and associated structures and requirements for lightning protection system components. Unless indicated otherwise, the extent of the lightning protection system designed, furnished, installed, Master Labeled and documented under this Section shall include all site buildings, structures and appurtenant installations, both new and existing, as required to provide "total" site lightning protection.

B. Product Data for each component specified.

C. Shop Drawings detailing lightning protection system. Include air terminal locations, conductor routing and connections, and bonding and grounding provision. Include indications for use of raceway and data on how concealment requirements will be met.

D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience.

E. Certification, signed by Contractor, that roof adhesive for air terminals is approved by manufacturers of both the terminal assembly and the roofing material.

F. Field inspection reports indicating compliance with specified requirements.

1.03 QUALITY ASSURANCE

A. Materials and installation to conform to NFPA 70, National Electrical Code and to NFPA 780, Lightning Protection Systems.

B. Installer Qualifications: Engage and experienced installer who is NRTL listed or who is certified by the Lightning Protection Institute as a Master Installer/Designer.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. Provide UL Master Label.

E. See also Spec 16010 Part 1 for listing of applicable reference standards.

1.04 SEQUENCING AND SCHEDULING

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

1.05 CONTRACT DRAWINGS

A. Contract Drawings for lightning protection systems furnished by Owner / Architect / Engineer to Contractor are diagrammatic in nature, and are intended only to provide general indication of the overall extent and intent of the lightning protection system scope. Materials and methods, where indicated, are generic and diagrammatic and are provided for illustrative purposes only. Quantities and details of materials and installation methods shall be developed by Contractor. Contractor shall submit his own catalog cuts of proposed materials and detailed design drawings for approval, as indicated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work, include, but are not limited to, the following:

1. A-C Lightning Security, Inc.
2. Approved Lightning Protection Co., Inc.
3. Heary Bros. Lightning Protection Co.
4. Thompson Lightning Protection Co.

2.02 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96.

B. Comply with NFPA 780, Class I or Class II as specified and / or required.

C. Hardware for Lightning Protection System: UL type and of the same material as the air terminal, or of brass or bronze, as approved for the application.

2.03 GROUND RODS

A. Copper-clad steel with a minimum of 27 percent of rod weight in copper cladding.

B. Diameter: 3/4 inch (19 mm).

C. Length: 10 feet (3 meter)

2.04 AIR TERMINALS

A. UL approved, solid copper or nickel, with a diameter not less than as required per NFPA 780, having the tip as specified or indicated.

2.05 ROOF/DOWN CONDUCTORS FOR LIGHTNING PROTECTION SYSTEM

A. Copper cable meeting UL 96, with minimum size per NFPA 780, or larger as indicated.

2.06 LIGHTNING PROTECTION SYSTEM

A. Consists of cables, air terminals, mounting bases, fittings, couplings, connectors, fasteners, and other devices for a complete, coordinated system including interconnections to ground rods and ground grid.

B. Materials, except bolts, screws, and related type hardware: Copper or high-copper content bronze or nickel, or brass, and the standard product of a manufacturer regularly engaged in production of lightning protection systems. Materials shall comply in weight, size, and composition for a Class I or Class II structure to be protected in accordance with NFPA 780. Bolt, screws, and related type hardware shall be stainless steel.

C. Fittings, except cable holders: Heavy-duty type bronze casting; stamped, pressed, and crimped type pressure devices are not permitted.

D. Methods of fastening air terminals to roof: Compatible with roof composition. Do not attach copper materials to aluminum; adhesives for attaching materials to roofing shall be approved for use by the specific roofing manufacturer.

2.07 BOND AND WELD SEALANT

A. Vinyl-backed compound

2.08 TRANSIENT VOLTAGE SURGE SUPPRESSORS

A. Furnish and install appropriate transient voltage surge suppressors or similar devices on all electrical, telephone, signaling, communication, television and similar service entrances at the protected building / structure.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces, areas, and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of lightning protection. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install lightning protection as indicated, according to manufacturers written instructions.

B. Comply with UL 96A, LPI-175, and NFPA 780.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Where indicated, run conductors in nonmetallic raceway, Schedule 40, minimum.

D. Conceal down conductors.

E. Conceal interior conductors.

F. Provide notification at least 48 hours before concealing lightning protection components.

G. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

H. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to lightning protection components.

I. Bond ground terminals to counterpoise conductor.

J. Bond grounded metal bodies on building within 12 feet (4 meter) of ground to counterpoise conductor.

K. Bond grounded metal bodies on building within 12 feet (4 meter) of roof to counterpoise conductor.

L. Bond lightning protection components to grounded metal bodies on building at every 60 feet (18 meter).

M. Bond all underground metal piping entering / exiting the structure to the ground loop or closest ground rod.

3.03 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.04 FIELD QUALITY CONTROL

A. UL Inspection: Apply for inspection by UL as required for UL Master Labeling of system. Submit evidence of master labeling for record.

END OF SECTION 16601

SECTION 16721
FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable addressable fire alarm system. All components shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings.

B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.

C. Refer to Sections 16000 (Electrical Power and Systems) for additional scope requirements.

1.02 RELATED WORK

A. Division 16 – Electrical

1.03 REFERENCES

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NFPA 70.
2. NFPA 72.
3. NFPA 101.
4. NEC Article 760.
5. Standard Building Code as amended and adopted by the City of Atlanta.
6. State of Georgia Rules of Safety Fire Commissioner.
7. ADA requirements.

B. All equipment comprising the system shall be listed and labeled by Underwriter's Laboratories, Inc.

1.04 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Relevant experience references.
2. Manufacturer's certifications.
3. Manufacturer's equipment data sheets.
4. Connection and wiring diagrams.
5. Operation and Maintenance Manuals.
6. Voltage drop calculations.
7. Standby battery calculations.
8. All complete "As built" system wiring drawings including field wiring to and from Fire Control panels shall be provided to the Engineer for review before work is accepted by the **City.**

B. Refer to Section 01350, Paragraph 1.03 for additional requirements.

1.05 QUALITY ASSURANCE

A. The Contractor shall comply with all requirements for permits and tests shall provide all certificates and shall pay all costs for same.

B. The fire alarm system shall be furnished by a single manufacturer who shall assume full responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the drawings.

C. Manufacturers shall provide written calculations and other data demonstrating that the equipment provided under this Specification has been amply designed and is a suitable application for these service conditions. A certificate of unit responsibility shall be provided. Nothing in this provision, however, shall be construed as relieving the Contractor of his overall responsibility for this portion of the work.

D. Unit responsibility certificates provided by suppliers, vendors, or other second party representatives of the pump manufacturer shall not be accepted.

E. Manufacturers offering equipment that complies with these specifications include:

1. Simplex Grinnell, 4100 System.
2. Firelite Alarms, Inc.
3. Gamewell.
4. Or equal.

1.06 DELIVERY, STORAGE AND HANDLING

A. Provide factory-wrapped waterproof flexible barrier material for covering materials, where applicable, to protect against physical damage in transit.

B. Handle materials carefully to avoid damage, breaking, denting and scoring. Damaged equipment or materials shall not be installed.

C. Refer to Section 16000 for additional requirements.

1.07 SPECIAL REQUIREMENTS

A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 GENERAL

A. The fire alarm system shall consist of local fire alarm control panels and addressable detection devices.

B. The fire alarm system shall have the capability for transmitting alarms and status of each alarm initiating and addressable detection device via fiber optic communication link to the central fire alarm control and monitoring system.

C. All devices shall be housed in enclosures suitable for the environmental and/or hazardous area classifications and conditions.

2.02 SYSTEM OVERVIEW

A. Two (2) fire alarm panels shall be provided and shall be located in the Diversion Facility Pump Station and the Jet Mixing Pump Station. The panels furnished under this section shall be capable of "Stand alone" operation. In addition, the new panels shall interface with the existing main fire alarm panel located an the R.M. Clayton Water Reclamation Center.

B. All panels shall be interconnected by fiber optic cable. All required hardware and software additions or modifications to the existing panel shall be furnished and installed under this Section and is included in this Contract.

2.03 PERFORMANCE REQUIREMENTS

A. The system shall include the following features as a minimum:

1. During an alarm condition, the associated alarm LED shall flash until acknowledged and this shall allow determination of where the last alarm has taken place.
2. Ground fault detection in wiring on either plus or minus side.
3. Separate alarm and trouble LED for each zone or addressable point.

4. "Dead" Front design control panel with all LED alarm trouble and power on indicators and all switches located behind a locked tempered glass door.

5. Resound features.

6. Solid state construction.

7. All alarm initiating circuit wiring, alarm signaling wiring and annunciator wiring shall be supervised.

8. Automatic transfer to standby batteries upon power failure.

9. Functional System Test capability which when in the test mode, activated initiating devices will report their individual addresses at the control panel and audibly via a code pattern and voice which automatically resets within four seconds. Integrity of the installation conductors and indicating appliance circuit can be verified by momentarily opening any circuit. The indicating appliance will operate for four seconds and automatically reset.

10. Smoke detector alarm verification operating whereby the system shall reset the alarmed detector and wait for a second alarm. If, after reset, a second alarm is reported from the same or any other smoke detector within one minute, then the system shall process the alarm per the operation listed above. If no second alarm occurs within one minute, then the system shall resume normal operations. This alarm verification operation shall be only for smoke detector alarms. All other sources of alarm shall be processed immediately.

2.04 LOCAL CONTROL PANEL

A. Provide surface mounted Fire Alarm Control Panels with a key lock.

B. Panels shall have a minimum of two SPDT alarm relays and one SPDT trouble relay. All relays shall have contacts rated at 3 amps 120/vac/24 vdc.

C. Panels shall have offsite monitoring output capability with converter for fiber optic connections to transmit alarm and trouble information to a central location.

D. Panels shall have 60 hours of battery reserve and shall be capable of sounding all alarm devices for at least ten minutes after the 60 hours.

E. Power supply unit shall be supervised for A.C. power interruption, blown fuses, battery charge, and loose, disconnected or reversed battery.

2.05 DETECTION DEVICES AND ALARMS

A. Manual Stations:

1. Furnish Wall Mounted Manual Alarm Stations as shown on the plans. The station body shall be so constructed that chips and scratches will not expose metal. All stations shall be master keyed with the control equipment. When actuated, the "pull lever" shall remain at a right angle to the station body until reset. Stations, which utilize screwdrivers, allen wrenches, or other commonly available tools shall not be accepted.

B. Photoelectric Smoke Detectors:

1. Provide Photoelectric Smoke Detector as shown on the plans. Detectors shall be of the solid-state photoelectric type utilizing a stable LED light source and a silicone photo diode as the receiving element to form a highly accurate means of smoke detection. Internal detector circuits shall be shielded against electrical interference and resistant to transients, "noise and RF interference".

2. Nominal detector sensitivity shall be 1.4% per foot obscuration with a range of 1% to 1.84%. Regardless of sensitivity settings, the detector's stability shall be unaffected by high air velocity. No radioactive materials shall be used.

3. Each detector shall have a dual purpose red LED. This LED shall blink continually to show that the device is powered. When the detector goes into alarm, this LED shall stop blinking and shall come on steady. In addition, every detector base must be capable of operating an auxiliary relay. This relay is to be used to release magnetically held doors, interface with the elevator controller, interface with the HVAC or pressurization system, or any other use deemed necessary now or in the future.

C. Alarm Signals:

1. Provide audio-visual unit with horn, and flashing light when activated. Provide trims for audiovisual units to match wall finish.

D. Duct Mounted Photoelectric Smoke Detectors:

1. Provide Photoelectric Duct Mounted Smoke Detectors with sampling tubes as shown on the plans. Duct mount smoke detectors shall be coordinated with the contractor and connected to the Fire Alarm System by the electrical contractor. Each detector to have its own SPDT 2 amp rated relay and be capable of operating a remote LED to indicate its alarm condition.

2. Each duct detector must be capable of either two or four wire operation.

E. Shutdown Relays:

1. Provide relays operated by the fire alarm system to shutdown associated motors vial electrically isolated relays/contacts.

2. Ratings shall be suitable for the load.

3. Wiring between the relays and the controlled devices is part of this Section.

F. Ionic Smoke Detector

1. Provide ionic smoke detectors as shown on the Drawings. Ionic smoke detectors shall be coordinated with the Contractor and connected to the Fire Alarm System by the Electrical Contractor.

2. The detector shall have a visible LED which will blink in standby and catch on in alarm. The detector shall have a sensitivity of 1.9±0.6%/ft., as measured in UL smoke box. Wiring connectors shall be made by means of SEMS screws.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide all equipment, wiring, conduit and outlet boxes required for the installation of a complete and operating system in accordance with applicable local, state and national codes, the manufacturer's recommendations, these plans and specifications. Color code shall be used throughout.

B. All local fire alarm control stations shall be connected to the fire alarm control panel over a fiber optic data highway. Provision shall be made for remote monitoring and control of each detection device.

C. Interconnection of fire alarm system devices shall be via approved wiring in conduit of the type suitable for the environmental and/or hazardous area classifications and conditions.

D. All conduit in corrosive areas shall be PVC coated rigid steel.

3.02 FIELD TESTS

A. The manufacturer's authorized representative shall provide supervision of final system panel connections, perform a complete functional test of the system and submit a written report to the contractor attesting to the proper operation of the system.

3.03 MANUFACTURER'S SERVICES

A. Warranty service for the equipment shall be provided by the manufacturer's factory trained representative during normal working hours, Monday through Friday excluding holidays.

B. All complete "As built" system wiring drawings including field wiring to and from Fire Control panels shall be provided to Engineer for review before work is accepted by the City.

C. Upon completion of the installation, the electrical contractor shall provide to the Engineer, a signed written statement from the manufacturer's representative attesting that all system equipment was installed in accordance with these Specifications and in accordance with wiring diagrams, instructions and directions provided to the contractor by the manufacturer.

D. After the equipment has been placed in satisfactory operating condition, the Contractor shall provide a minimum of one (1) working day of training of the City's personnel on the operation and maintenance of the system.

END OF SECTION 16721

SECTION 16742
TELEPHONE/DATA SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections apply to this Section.

1.02 SUMMARY

A. Telephone/Data Raceway Systems:

1. Drawings and General Provisions of the contract include General and Supplementary Conditions and Division 1 Specification sections apply to this section.
2. Miscellaneous Electrical Materials and Methods sections apply to work specified in this section.
3. The Contractor shall furnish and install a complete telephone/data raceway system including connection from utility pole to the telephone backboard.

B. Telephone/Data Systems:

1. Route all telephone circuits to the telephone backboard.
2. Route all data circuits to the data backboard.
3. Emergency phone.
4. Provide conduit sleeves (two (2) 4 inch conduit unless noted otherwise) between the point of telephone company incoming service and the telephone closet.

1.03 REFERENCED DOCUMENTS

A. Industry Standards:

1. American National Standards Institute (ANSI):
   a. C2 National Electrical Safety Code
2. National Electrical Manufacturers Association (NEMA):
   a. ICS 6 Enclosures for Industrial Controls and Systems

1.04 SUBMITTALS

A. General: Submit the telephone equipment according to the Conditions of the Contract and Division 1 Specifications Sections.

B. Submit operation instructions, detailed parts list, recommended spare parts list, cable wire lists, circuit diagrams, maintenance procedures, and troubleshooting procedures.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70, for components and installation.

B. Testing of installed products, specified in this Section, shall be performed by persons having not less than five (5) years of telephone cable and equipment testing experience.

PART 2 - PRODUCTS

2.01 PRODUCTS

A. Wall boxes shall be 4-11/16" X 4-11/16" square with stainless steel cover and 4-1/2" x 4-1/2" square and minimum 2-1/2" deep.

B. Conduit and fittings shall be as specified.

C. Jacks: Each jack shall be clearly labeled with a jack location number corresponding to a label on the station block for that particular termination.

1. Telephone: RJ-11.
2. Data: RJ-45.

D. Cable: Category five (4 pair) cable from each jack location to the backboard.

1. Telephone Cables shall be terminated on an AT&T S110 modular terminal blocks. Each termination on the terminal block shall be labeled with a corresponding jack location number.
2. Data Cables shall terminate with a RJ-45 male connector. Each cable shall be labeled with a corresponding jack location. Provide 6 feet of slack cable.
3. Plenum rated cable.

E. Plywood backboards shall be exterior grade, 4'-0" X 8'-0" X 3/4" thick, located as shown on the Drawings. Backboards shall be treated with fire retardant, gray primer and painted with two coats of flat gray paint.

F. Wire Manager – The Contractor shall furnish and install wire managers.

PART 3 - EXECUTION

3.01 EXECUTION

A. The Contractor shall contact and verify with local telephone company serving the existing area, regarding disconnection and reconnection of temporary services (where required) and equipment supplier prior to installation of any electrical work.

B. The Contractor shall furnish and install a complete system of cabinets, outlet boxes, conduit and miscellaneous fittings and materials to provide a complete system.

C. The Contractor shall verify the type and arrangement of the equipment with telephone and data equipment supplier prior to the installation of any electrical work. Any work installed, which

must later be relocated as a result of the Contractor negligence in coordinating with the equipment supplier shall be done as directed by the Owner's Representative at no additional cost.

D. Desk telephone shall have wall boxes mounted 12 inches above finished floor unless otherwise note. The boxes shall be double gauged stainless steel with cover plate, modular outlet and jack.

E. Wall telephone shall be furnished with a box similar to the one specified for the desk telephones and mounted 48 inches above finished floor. The outlet shall be equipped with necessary cover plate for wall telephone installation.

F. Stub 3/4 inch conduit from outlet boxes to above accessible ceiling. Route cables to backboard. Tie wrap cables together and to structure for support. Do not route cables on top of lay-in ceiling grid or panels.

G. A nylon fish wire shall be installed and left in place in all empty conduit runs.

H. Use 1-1/2 inch sleeve or conduit for penetrations in walls, extending a minimum of 6 inch on both sides of the wall. Provide appropriate sealants and stopping for fire rated walls.

3.02 SYSTEM TESTS

A. Cables: Test shields and conductors for open and shorts. Measure loop resistance of each pair. Measure insulation resistance.

END OF SECTION 16742

SECTION 16960
CONTROL CIRCUITS AND PILOT DEVICES

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes furnishing, unless otherwise indicated, and installing all materials and providing all labor and supervision pertaining to control circuits and pilot devices.

B. Unless otherwise indicated, all pilot devices, such as pushbutton stations, selector switches, thermostats, firestats, smoke switches, pressure switches, limit switches, float switches, flow switches, pneumatic-electric switches, recorder controllers, and the like, shall be furnished by the supplier of each item or group of items of driven equipment specified in other Divisions of these specifications. The Contractor shall refer to the appropriate Divisions under which driven equipment, or control system applicable thereto, is to be furnished for all specific requirements which may have a bearing on work under this Section, and shall provide the proper services and other electrical work required to make the equipment operable.

C. In general, all "line" voltage (120 volts and higher) control wiring shall be provided under this Section and lower voltage wiring, such as for low voltage temperature control systems and the like, shall be furnished under the requirements of other Sections.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:

1. Catalog cuts, electrical ratings, adjustment ranges, enclosure types and dimensions, necessary internal and interconnection diagrams, etc.

1.03 QUALITY CRITERIA

A. Control devices shall comply with U.L., NEMA, and N.E.C. requirements.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Pilot devices shall generally be heavy-duty industrial type with adequately rated precious metal contacts and with enclosures suitable for the type and class of area and for the environment in which they are to be installed.

B. Specific requirements for pilot devices to be provided under this Division shall be as indicated on the drawings or as called for under other Sections of this Division.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Pilot devices and wiring thereto shall be properly supported.

B. Control circuits shall be provided and connected in accordance with diagrams indicated on the drawings and/or in accordance with diagrams to be furnished by the supplier of the driven equipment or by the supplier of the control system involved therewith.

C. All required device adjustments and settings and all required re-connections shall be provided to make all systems and equipment operate in a satisfactory manner.

END OF SECTION 16960

SECTION 16999
ACCEPTANCE TESTING AND CALIBRATION

PART 1 - GENERAL

1.01 SCOPE

A. This Section includes the field testing, inspection and adjusting of all material and equipment installed. Other Electrical Sections covering individual types of equipment may have additional testing requirements.

1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements including the partial listing below:

1. NEC, National Electrical Code.
2. NEMA, National Electrical Manufacturers Association.
3. ASTM, American Society for Testing Materials.
4. IEEE, Institute of Electrical and Electronics Engineers.
5. NETA, National Electrical Testing Association.
6. ANSI, American National Standards Institute.
7. IPCEA, Insulated Power Cable Engineers Association.
8. OSHA, Occupational Safety and Health Act.

B. Items not passing test will be rejected and shall be repaired or replaced with acceptable new items. The repaired and replacement items shall be tested.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Inspect, test and calibrate in accord with manufacturer's instructions supplemented by this Specification.

B. Institute and maintain rigorous precautions for all test procedures. Maintain telephone or voice radio contact between the potential source location and energized remote locations during any potential testing operations.

C. Contractor shall utilize the services of a testing firm, approved by the Engineer, which is regularly engaged in the testing of electrical equipment, devices, installations and systems to conduct all of the testing specified in this Section. The testing firm shall meet the qualification criteria set forth in NETA acceptance testing specification.

3.02 POWER CIRCUIT BREAKERS

A. Preparatory Work: Prior to testing, remove each breaker from its compartment. Clean, lubricate, inspect and adjust each breaker in accord with manufacturer's published maintenance instructions. Inspect contacts, arc quenchers, primary and secondary disconnects, current sensors, small wiring and trip devices. Examine contacts for condition, clearance, pressure and wipe.

B. Tests and Data: Determine and record the following data:

1. Breaker identification, including City's designation, manufacturer's ratings, serial number, trip device type, ranges and time bands.

2. Test each breaker electrically for proper tripping characteristics by passing 60 Hz. sinusoidal low voltage current through each pole, one at a time, with test current injection at the primary disconnects. Adjust trip devices for required pickup characteristics. Perform tests at operating trip device settings as specified. Include this information in the report plus the record of the settings "as left" after calibration.

3. Apply sufficient current to actuate each mode of trip device, i.e., long time pickup, long time delay band, short time pickup, short time delay band, instantaneous pickup, ground pickup and ground delay band as applicable. Test current and elapsed time at tripping. For each pole, state whether or not breaker tripping is within the manufacturer's tolerances.

4. Perform insulation resistance test on each breaker. With contacts closed, apply 1,000 volts DC for each 600 V and under and 250 V DC up to 5 KV and make readings after one minute energization between each pair of poles and from each pole to the breaker frame.

C. Molded Case Circuit Breakers and Motor Circuit Protectors. Test automatic molded case circuit breakers for acceptance. Quantity to be tested is indicated below.

1. Thermomagnetic Trips. (Breakers Only). Test breakers having thermomagnetic trips in a temperature controlled environment maintained at 400 C plus or minus 30 C. A temperature stabilization period of 15 minutes is required prior to testing the inverse-time automatic tripping characteristics. Test each pole of each breaker at 90% and 200% of its continuous current rating. Replace any breaker or trip device which trips within 10 minutes at 90%, or which fails to trip at 200% within the time indicated in the following table:

Rated Continuous Current, Amperes	Max. Tripping Time, Minutes	Breakers tested per Panel or Switchboard
15 - 40	2	10% (not less than 2)
50	4	20% (not less than 1)
60 - 100	6	50% (not less than 1)
125 - 225	8	100%
250 - 400	10	100%
500 - 600	12	100%
700 - 800	14	100%
1,000	16	100%
1,200	18	100%

2. Instantaneous Trips. Test each pole of each breaker and motor circuit protector for automatic instantaneous tripping with slowly rising current. Replace any breaker or trip device which fails to operate within the following values:

3. Non Adjustable Trips - plus or minus 20% of fixed setting. Adjustable Trips - plus or minus 10% of the high setting of the rms values of the instantaneous tripping current.

4. Motor Circuit Protectors after testing shall be placed in service at the minimum position which permits motor starting based on motor nameplate data following MCP manufacturer's instructions.

3.03 MOTORS AND MOTOR CONTROLS

A. Inspect and test motors and motor wiring, power and control for proper connection, circuit continuity, wire identification, insulation resistance and proper functioning or operation. Test insulation resistance from line to line and from each line to ground with a test instrument. Make tests prior to energizing circuits. Test motors for correct rotation. Test proper operation of starters and control devices. Record the nameplate data of motors for the selection of the proper overload relay heater size.

B. Test and inspect power distribution equipment for damage, defects and for proper functioning of all electrical and mechanical components. Test line and load bus, connections and conductors and test circuit breakers for proper electrical and mechanical operation.

C. Place motor circuit protectors in service at the minimum position which permits motor starting, based on motor nameplate data and following MCP manufacturer's instructions.

3.04 LIQUID FILLED TRANSFORMERS

A. Inspect for physical damage, cracked insulators, leaks and tightness of connections. Verify proper auxiliary device operation. Verify proper liquid level in all tanks and bushings. Perform specific inspections and mechanical tests as recommended by manufacturer. Verify proper equipment grounding.

B. Perform insulation-resistance tests, winding-to-winding, and windings-to-ground. Perform a turns-ratio test between windings at all tap positions. Sample insulating liquid in accordance with ASTM D-923. Sample shall be laboratory tested for, acid neutralization number, specific gravity, interfacial tension and color.

C. Perform all other tests not specified here, but required to conform to the requirements of NETA.

3.05 SPECIAL SYSTEMS

A. Exercise care in the testing of electrical systems so as not to damage special, electronic or instrumented circuits. Do not undertake to check or test special electronic or instrumented circuits beyond the manufacturer's instructions included with the equipment and performed for

B. equipment installation. Test the continuity only for alarm, instrumentation, or similar special wiring systems prior to the final equipment connections.

C. Medium Voltage switchgear 15kV shall have hi-pot testing.

3.06 INSULATION TESTS

A. Furnish the necessary test equipment and labor to test the insulation of electrical equipment and circuits before they are energized. Use a 1,000 volt "Megger" or other approved instrument, to test the insulation resistance of circuits insulated for 600 volts, associated motors and transformers, low-voltage motor control centers and low voltage switchboard.

B. Insulation Tests: Include, but are not limited to, the following:

1. Transformers: Test primary to ground, secondary to ground and primary to secondary.
2. Services: Test phase to phase and each phase to ground.
3. Cables: Test phase to phase and each phase to ground.
4. Perform continuity test to ensure proper cable connection.
5. Motors: Test winding to ground.
6. Load Side of 600 Volt Circuits: Test each phase to ground and phase to phase.
7. Minimum Acceptable Megger Readings (Megohms at 20 C) for 600 volt class equipment:

Transformers	Megohms
Primary to ground	20
Primary to Secondary	20
Secondary to Ground	5
Services - Motor Starters and Buses	20
Motors	2
Load side of 600 volt circuits less motor	20

C. Control power transformers, potential transformers and other devices connected phase to phase or phase to ground and any devices not designed to withstand the test voltages must be disconnected when testing insulation resistance in switchboard, motor control centers and other apparatus.

D. Keep written record of tests performed on forms approved for the purpose and turned over to Engineer upon request, or at the termination of the Work. Identify each circuit or piece of apparatus tested, the date of the test, the temperature at the time of testing, the instrument used, the test voltage applied, the resistance values found and the name of the person in charge of and witnessing the test.

3.07 FINAL INSPECTION AND TEST

A. Upon completion of the various phases of the project, or at convenient times during progress of the Work, check and/or test as herein specified all equipment and wire installed.

B. Upon receipt of written notice that the work has been completed, including tests herein specified, Engineer's representative will give the entire work a thorough inspection. Any defects or omissions noted shall be corrected before acceptance of the work.

C. The inspections and tests to be made by the Contractor shall include, but are not limited to, the following:

1. Visually inspect wires and cable connections including internal wiring of switchgear, transformers and other equipment.
2. Verify continuity of power and control conductors.
3. Make insulation tests as herein specified.
4. Check control circuits for short circuits and extraneous grounds.
5. Check equipment for proper mechanical adjustment and freedom of operation and removal of shipping blocks and/or stops.
6. Check closing, tripping, supervision and alarm functions of the controlled equipment.
7. Operate motor controllers, contactors, etc., from their control devices.
8. Check operation of alarm circuits.
9. Check motors for proper rotation and motor currents measured under load conditions. Any motor found to be operating incorrectly shall be inspected to determine the cause and the condition shall be corrected to the satisfaction of Engineer. Furnish a record of these tests to Engineer.

END OF SECTION 16999

FC-6260

Peachtree Creek South Fork
Relief Storage and Pumping Stations

Reference Materials

REPORT OF SUBSURFACE EXPLORATION AND GEOTECHNICAL ENGINEERING EVALUATION

Liddell Drive Equalization Project

(Revised October 9, 2012)

Atlanta, Fulton County, Georgia

WILLMER ENGINEERING INC.
Willmer Project No. 71.3801

Prepared For

Atlanta Services Group
Atlanta, Georgia

Prepared By

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Original Issue Date: April 23, 2012
(Revised October 9, 2012)

VIA EMAIL

Atlanta Services Group
c/o Don Fry, PE
Engineering Design Technologies, Inc.
1705 Enterprise Way
Suite 200
Marietta, GA 30067

SUBJECT: Subsurface Exploration and Geotechnical Engineering Evaluation
Liddell Drive Equalization Project
Atlanta, Fulton County, Georgia
Willmer Project No. 71.3801

Dear Mr. Fry:

Willmer Engineering Inc. (Willmer) is pleased to support our Atlanta Services Group (ASG) team by providing this report of subsurface exploration and geotechnical engineering evaluation for the proposed Liddell Drive Equalization project in Atlanta, Fulton County, Georgia. This work was performed in general accordance with our proposals No. 12.P116, dated February 6, March 23, April 17, May 25, and September 27, 2012. The results of our evaluation and our recommendations are summarized in this report. This report was revised to incorporate additional borings for foundation recommendations for the east side pump station and diversion structures and for some changes made to the equalization tank location and force main alignment.

This report presents our understanding of the proposed development, the results of our geotechnical exploration, analyses, and evaluation and our recommendations for the design and construction of the proposed facilities.

We greatly appreciate the opportunity to be of service to you on this project. Please contact us if you have any questions concerning this report or require further assistance.

Sincerely,

WILLMER ENGINEERING INC.

Daniel C. Pitts, EIT
Staff Geotechnical Engineer

Sujit K. Bhowmik, PhD, PE
Chief Engineer

James L. Willmer, PE
Executive Vice President/Principal Consultant

The original of this document was signed and sealed by James L. Willmer, PE, Registration No. 10780 on October 9, 2012.

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Executive Summary

The following summary highlights significant aspects of the project and our conclusions and recommendations. The reader is referred to the report text for detailed descriptions of our subsurface exploration and geotechnical analyses and recommendations.

- The Liddell Drive Equalization Project includes an equalization tank (185 feet internal diameter and 52 feet high), a 48-inch diameter force main, installed from north fork of Peachtree Creek, under Cheshire Bridge Road and to the tank, diversion structures at the creek, a 48-inch diameter diversion pipe, pump stations, and other associated structures and appurtenances.

- Forty-one Standard Penetration Tests (SPT) borings were drilled for the proposed tank location and for previous tank alternative locations, for the force main alignment, and to study alternate pipeline alignments. Rock coring was performed at thirteen boring locations.

- The soil conditions at the force main pipe invert elevations vary between fill, alluvial soils, residual soils, PWR, and weathered rock/rock. Undercutting of soft alluvial soils and replacement with No. 57 stone will be required at some locations. Also, undercutting of rock and PWR and replacement with No. 57 stone will be required in some areas to provide uniform support in the transition areas from soil to PWR and rock.

- A jack and bore tunnel will extend 300 feet under Cheshire Bridge Road through mixed soil conditions consisting of fill and residual soils.

- We recommended that the tank bottom be supported directly on PWR/rock; undercutting of up to 6 feet of soils and replacement with compacted GAB will be required in some parts of the tank footprint. Alternately, a combination deep foundations and the tank bottom bearing directly on rock can be used. For the tank bottom bearing directly on rock/PWR, allowable bearing pressures of 10 and 20 ksf are recommended for PWR and rock, respectively. For the deep foundation option, 120 ton capacity auger-cast piles can be used.

- Rock anchors can be used to resist hydrostatic uplift load at the tank, pump stations, and diversion structures. An uplift load capacity of 130 kips can be achieved with 6-inch diameter anchors embedded 16 feet into rock.

- Temporary bracing will be required for excavation support for the force main trench, jack and bore tunnel pits, pump station, diversion structure, and the equalization tank area. Sheet piles or H-piles may encounter refusal in the existing miscellaneous debris fill encountered in the tank area. The debris fill should be excavated prior to installation of the excavation support system. Dewatering will be required during excavation.

- We recommend that Willmer Engineering Inc. be retained to provide geotechnical engineering oversight during construction of the facilities to confirm that the subsurface conditions encountered during construction are consistent with our interpretation based on the results of our geotechnical exploration and that the recommendations provided herein are properly interpreted and implemented.

1.0 .Introduction

1.1 Project Description

The Peachtree Creek sewer system conveys wastewater generated in the City of Atlanta (COA) Peachtree Creek basin and in the intergovernmental basin in DeKalb County to the R. M. Clayton Water Reclamation Facility for treatment. DeKalb County's connections to the COA collection system in the Peachtree Creek basin are located on the North Fork Peachtree Creek Trunk Sewer and the South Fork Peachtree Creek Trunk Sewer near the DeKalb County/Fulton County boundary. The capacity of the piping system is sufficient to convey dry weather flows but not peak flows generated during wet weather. As a result, sanitary sewer overflows (SSOs) have occurred during periods of wet weather. A new equalization storage system has been planned to prevent wet-weather SSOs. The proposed equalization system will temporarily store peak flows and then return the stored flows to the collection system when peak flows subside. The stored flows will be pumped back into the relief sewers at a controlled rate.

Sanitary sewer flow will be diverted from the existing South Fork Peachtree Creek Relief Sewer through a 48-inch diameter force main. Flows will be equalized in a tank constructed on property owned by the City of Atlanta adjacent to Liddell Drive as shown in Figures 1 and 2. There is an AM radio station antenna tower in the central part of the proposed site, and the site is leased for use by the radio station until 2014. The City plans to expedite the removal of the tower before the lease expiration in order to use the site efficiently for wastewater flow equalization. At this time, it is anticipated that the tower will be removed before construction of equalization facilities begins.

1.2 Description of Proposed Facilities

The proposed location of the tank is shown in Figure 2. The tank will have a cylindrical shape with a conical bottom. The conical bottom of the tank will have a slope of about 12 to 1 towards the center. Dimensions and elevations of the proposed tank are summarized below:

Proposed Structure	Dimensions (approximate)	Foundation Level
Equalization Tank	185 feet internal diameter 52 feet tall	Perimeter EL. = 802 feet Conical Bottom EL. = 794.5 feet
Equalization Pump Station	56 feet by 74 feet	783.5 Feet
Diversion Pump Station	67 feet by 82 feet	Lower Level = 781 feet Upper Level = 804 feet
Diversion Structures	19 feet by 22 feet	Bottom #1 = 792.5 feet Bottom #2 = 791.5 feet

As noted above, the tank will have an internal diameter of 185 and will be 52 feet in height. The tank will store approximately 50 feet of water. The tank is to be constructed of pre-stressed concrete, and the pressure exerted at the tank bottom is anticipated to be about 3600 pounds per square foot (psf). The expected foundation levels of the tank perimeter bottom and conical bottom range from about 35 to 45 feet below the existing grade.

New diversion structures will be constructed at the existing South Fork Peachtree Creek Relief Sewer at the eastern end of the project site. Also near the east end of the alignment, proposed construction includes an electrical building, an odor control building, and a diversion pump station.

The flow from the diversion structures will be transported to the equalization tanks using a new 48-inch diameter force main. The proposed alignment and profile of the force main are shown in Figures 2 and 3, respectively. As shown in Figure 3, the invert elevation of the force main ranges from about 789.8 feet at the west end near the equalization tanks to about 861.5 feet at the junction box north of Cheshire Bridge Road to about 810 feet at the east end near the diversion pump station. A jack and bore tunnel will be used to install the force main under Cheshire Bridge Road. The proposed tunnel is approximately 300 feet long, extending from the west side to the east side of Cheshire Bridge Road.

Other structures to be constructed as part of this project include an equalization pump station located adjacent to the equalization tank, an odor control system, and an access road connecting the tank area to Liddell Drive.

In addition, a flood plain compensation area east of Cheshire Bridge Road is planned for this project. Also, retaining walls along the pipe alignment and at various locations on the site are proposed. However, evaluation of the flood plain compensation area is not included in our present scope of work, and retaining wall details are not available at this time.

Our understanding of the proposed construction as described above is based on a plan and profile of the pipeline and tank information provided to us by ASG on October 5, 2012. If there are significant changes to the pipeline profile or tank configuration, we should be notified to re-evaluate and revise our recommendations accordingly.

1.3 Existing Site Conditions

The Liddell Drive Equalization Project is located within a suburban/urbanized environment with developed commercial properties and associated infrastructure located adjacent to the proposed force main alignment and tank site. The existing topography in the project area varies from elevation 877 feet near the junction box north of Cheshire Bridge Road to elevation 811 feet near the diversion structures at the east end near the creek. There are significant grade changes along the proposed force main alignment as fill materials were used to create the roadway embankment for Cheshire Bridge Road and the nearby building areas.

The equalization tank will be constructed in a partially paved area at the northwestern corner of the project site, east of Liddell Drive within property owned by the City of Atlanta. Currently this portion of the site is occupied by an AM radio antenna tower and temporary office trailers. The existing ground surface elevation in the proposed tank area ranges from about 834 to 845 feet.

2.0 Field Exploration Program

2.1 General

A field exploration program was conducted by Willmer to determine the type, strength, and deformation characteristics of *in situ* soils and to assess the groundwater conditions at the site of the proposed development. The field exploration consisted of Standard Penetration Test (SPT) borings, rock coring, bulk soil sampling, undisturbed soil sampling, piezometer installation, and groundwater table measurements at selected locations along the force main alignment and in the tank areas.

Existing subsurface utilities at the boring locations were located by the subscribers of Georgia Utilities Protection Center and a private utility locator. Upon completion of drilling and groundwater table measurements, the boreholes were backfilled using soil cuttings from the drilling operation. In paved areas, the surface of bore holes was patched with asphalt/concrete patch after backfilling.

2.2 Standard Penetration Test Boring

The subsurface exploration program consisted of drilling 40 SPT borings along various pipeline alignment options for multiple tank locations and in the proposed equalization tank area. The boring locations were selected by Willmer and ASG. All boring locations and elevations (except for B-26 through B-40) were surveyed in the field by a survey crew provided by ASG. B-26 through B-40 were located by our field engineer using estimated distances from existing site features, and the elevations at these locations were estimated from topographic drawings provided by ASG. The boring locations are shown on Figure 2.

Of the 40 SPT borings, 11 borings (B-15 through B-23, B-11 and B-38) were used to assess the feasibility of previously selected pipeline alignment options which were subsequently abandoned by ASG. Borings B-1 through B-9 and B-29 through B-37 were drilled in the tank area. Boring B-10 was drilled for a previously proposed electrical and generator building in the tank area. Borings B-13B, B-14, were drilled for the jack and bore tunnel under Cheshire Bridge Road. Borings B-11, B-13A, B-24, and B-38 were drilled to evaluate alternative alignments of proposed tunnels crossings under Cheshire Bridge Road. The currently selected jack and bore tunnel alignment passes through Boring B-13B and B-14.

It should be noted that the force main alignment was recently revised after the completion of our field exploration program and no boring was performed for the force main between boring B-13B and the equalization tank. Additional geotechnical exploration should be performed in this area to characterize the existing subsurface conditions that may impact the force main alignment and construction.

The borings were drilled using a rubber-tired all-terrain vehicle (ATV)-mounted rotary drill rig to advance continuous hollow-stem augers. All work was performed under the observation of our geotechnical engineers. The SPT borings were performed in general accordance with ASTM Standard D 1586. The Standard Penetration Test is a widely accepted method for *in situ* testing of soils. A 2-foot long, 2-inch outside-diameter split-spoon sampler attached to the end of a

string of drilling rods is driven 18 inches into the ground by successive blows of a 140-pound hammer freely dropping 30 inches. The number of blows needed for each 6 inches of penetration is recorded. The blows required for the first 6 inches of penetration are allowed for seating the sampler into any loose cuttings, and the sum of the blows required for penetration of the second and third 6-inch increments constitutes the penetration resistance or N-value. After the test, the sampler is extracted from the ground and opened to allow visual examination and classification of the retained soil sample. The N-value has been empirically correlated with various soil properties including consistency, relative density, strength, compressibility, and potential for difficult excavation. Correlations between the N-value and the relative density of cohesionless soils (sands) and consistency of cohesive soils (clays/silts) are included in Appendix I.

Results of the SPT borings are summarized in Table 1, and presented in the form of individual boring logs in Appendix I along with a list of the legends used in the boring logs, and a reference sheet describing the Unified Soil Classification System.

2.3 Rock Coring

Rock coring (NQ size) was performed at thirteen selected boring locations to obtain samples of auger refusal materials for use in evaluation of excavation methods and foundation bearing capacity. The depth of rock coring, percent recovery (REC) of rock core and the Rock Quality Designation (RQD) are presented on the boring logs in Appendix I. Percent recovery is defined as the length of rock core recovered divided by the total length cored. RQD is defined as the fraction of core run with rock core pieces equal to or longer than 4 inches; it is computed by summing the length of intact rock core pieces 4 inches or longer (ignoring mechanical breaks) and dividing the sum by the total length of the core run. Percent REC and RQD provide an indication of the continuity, fracturing, and degree of weathering of the rock.

2.4 Piezometer Installation

Temporary piezometers were installed at boring locations B-1, B-2, B-6, B-8, and B-11 to monitor the variation in groundwater level during the period of our field exploration program and to estimate the stabilized groundwater levels at these locations. The total depth of the piezometers ranged from 25 to 27 feet below the existing ground surface. The piezometers consisted of 5-foot long, 2-inch diameter slotted PVC pipes installed at the bottom of the drilled hole and connected to 2-inch diameter solid PVC pipes rising up above the ground surface. Clean sand was used to backfill the 5-foot screened zone (i.e., the annular space between the slotted pipe and the drilled hole). An 8-inch thick bentonite seal was used above the screen zone, and soil cuttings were used to backfill above the bentonite seal. Water samples were obtained from the piezometers for limited environmental testing; results of environmental sampling and testing are provided in a separate report.

2.5 Soil Sampling

Soil samples (split-spoon and bulk samples) obtained during the field exploration program were classified by our geotechnical engineer. Split-spoon samples were obtained from all borings and placed in glass jars. A bulk sample was collected in a plastic bag from boring B-10 at a depth of 1 to 5 feet below the existing grade. The samples were transported to our laboratory for further

classification and characterization. Soil classification was performed in general accordance with ASTM D 2487 / D 2488 classification system.

During SPT boring, undisturbed Shelby tube samples were also obtained from selected soils for possible use in laboratory consolidation/triaxial testing. Locations of the undisturbed samples are shown on the individual boring logs in Appendix I. The undisturbed samples were obtained from boring locations B-3 and B-4 for previous equalization tank alternatives.

2.6 Ground Water Level Measurement

Depth to groundwater was recorded where encountered during drilling. The water table elevations at the boring locations are summarized in Table 1, and shown on the individual boring logs in Appendix I. The depth to the groundwater table ranged from 3 to 42 feet below the existing ground surface, and groundwater elevations ranged from 802 to 836.6 feet.

2.7 Rock Outcrop/Boulders

Exposed rock/boulders were observed at a number of locations on existing slopes adjacent to the Seaboard Coastline Railroad extending along the eastern portion of the site. Based on the boring data for adjacent areas and close visual observation of the exposed materials, we determined that these are rocks/boulders in the fill materials that were used for site grading in these areas.

3.0 Laboratory Testing Program

3.1 General

A laboratory testing program was conducted by Willmer to determine the engineering properties of soils for use in our analyses and recommendations for the proposed facilities. The laboratory testing program consisted of: (i) classification and index tests on recovered split-spoon, bulk, and undisturbed soil samples, (ii) Standard Proctor compaction and California Bearing Ratio (CBR) tests on a remolded bulk soil sample, and (ii) triaxial compression tests on a selected undisturbed soil sample. All laboratory tests were performed in general accordance with appropriate ASTM standards.

3.2 Classification and Index Tests

Classification and index tests were performed to aid in the characterization of soil samples obtained from the boring locations. The tests included visual classification in the laboratory, grain size distribution analyses (ASTM D 422), and percent fines (i.e., percent by dry weight of materials passing the US #200 sieve) determination (ASTM D 1140). Results of these tests are summarized in Tables 2 and 3, and the individual test results are included in Appendix II. As shown in Tables 2 and 3, the tested samples were mostly sandy silt, silty sand, sandy clay with natural moisture contents ranging from 6.3 to 49.4 percent. The percent fines of the samples ranged from 36.5 to 57.4 percent, the liquid limit of the samples ranged from 25 to 49 percent, and the plasticity index of the samples ranged from 5 to 17 percent.

3.3 Standard Proctor Compaction and CBR Tests

A bulk soil sample was obtained from B-10 performed at the proposed electrical and generator building location. The bulk sample was obtained from a depth near the proposed final grade of the building. The bulk sample was used for Standard Proctor Compaction tests to determine the compaction characteristics of the soil. The result of the test is presented in Table 2. The Standard Proctor maximum dry density for the sample was 121.3 lb/ft^3 and the optimum moisture content was 12.0 percent. The natural moisture content for the sample was 6.3 percent. Based on this test, the natural moisture content is 5.7 percent lower than the Standard Proctor optimum moisture content.

A California Bearing Ratio (CBR) test was performed on the sample selected for compaction testing to determine the subgrade-support characteristics of the soil. The CBR test was performed on a specimen molded 100% of the Standard Proctor maximum dry density at a moisture content approximately equal to the optimum moisture content. The CBR value was determined to be 16.7. It should be noted that this CBR value is significantly higher than what is usually obtained for this type of soil (silty clayey medium to fine sand).

3.4 Triaxial Compression Test

A Consolidated Undrained Triaxial Compression tests (ASTM D4767) with pore water pressure measurement was performed on an undisturbed soil sample obtained from boring B-4 to determine shear strength parameters for this soil. Because of the nature of the soil and the presence of non-homogeneous materials in the Shelby tube sample, only one specimen was

suitable for use in triaxial test. The test specimen was consolidated using a uniform effective confining pressure of 15 psi prior to shearing under undrained conditions. Results of the triaxial compression test are presented in Table 3. As shown in this table, the effective stress friction angle for this sample was 24.8 degrees with a zero cohesion intercept.

4.0 Area Geology and Subsurface Conditions

4.1 Area Geology

The Liddell Drive Equalization project is located in the Southern Piedmont Geologic Province of Georgia. The Southern Piedmont has a soil weathering profile above the unweathered parent rock, which is formed by in-place mechanical disintegration of the original rock mass structure and chemical decomposition of the original rock mass material. The mechanical processes include stress relief from unloading due to erosion and the resulting differential strains and displacements. The predominant rock types along the project alignment are described as biotite gneiss, mica schist, and amphibolite.

The weathered profile can vary considerably over short distances due to variations in rock type or structure, topography, rates of erosion, groundwater conditions and regional variations in climate, particularly rainfall. The profile can be described as residual soil overlying weathered rock, underlain by relatively unweathered rock. The contacts between these zones are often very irregular and gradational. Near the surface, the residual soils are often fine grained and no indication of the original structure of the rock mass remains. With depth, the original relic rock structure can be recognized although the material is still soil. The relic rock structure includes joints and faults. Minerals are oriented identical to their original relative position, but feldspars are converted to kaolinite or other clays, micas are partially or completely degraded and altered, and most other minerals, except quartz, are altered. This results in a rock appearance but soil consistency and behavior. The relic structure inherited from the parent rock persists and results in planes of weakness.

Sandy silts and silty sands predominate, and highly micaceous zones or bands are common when micas were present in the original rock. Saprolite is the term commonly applied to this zone of soil-like material that retains the relic rock structure. The silty and sandy size materials of this zone can be very compressible, particularly when micaceous, and are very susceptible to erosion.

The base of the saprolite is locally defined as partially weathered rock (PWR) and is characterized as soil that exhibits a standard penetration resistance in excess of the equivalent of 100 blows per foot. The thickness of the PWR can vary considerably from less than one foot to in excess of 20 feet. This zone is often composed of larger sand sizes and can exhibit high permeability. The presence of PWR usually indicates the transition to weathered rock.

Weathered rock is characterized by a wide range of physical properties of its components, from soil-like appearance to rock-like corestones. Weathering has occurred more rapidly along the pre-existing joints and faults and along lithologic units that are more susceptible to weathering. This zone is the cause of a great many engineering problems. With further depth, the rock has noticeable discoloration, alteration of feldspars and micas, and some staining along joints. Eventually unweathered, but possibly still jointed, rock is found.

The above-described subsurface profile can be altered by alluvial erosion or deposition near drainage features or by man through excavation or fill placement.

4.2 Subsurface Conditions

Results of the SPT borings are presented in the form of individual boring logs in Appendix I. A summary of the boring records is presented in Table 1, and subsurface profiles obtained from the boring logs are presented in Figures 3 through 7. The stratification lines shown on the boring logs represent our interpretation of the field logs and laboratory test results, in accordance with generally accepted geotechnical engineering practice. The stratification lines represent approximate transition boundaries between soil types; actual transitions between soil types are expected to be gradual. Although individual test borings are representative of the subsurface conditions at the precise boring locations on the dates shown, they are not necessarily indicative of the subsurface conditions at other locations or at other times. Also, in the absence of foreign substances, it is difficult to distinguish between virgin (undisturbed) residual soils and clean soil fill; the soil was classified as fill only at locations and depths where the fill material was visually distinguishable from residual soils.

In the subsurface profiles presented in Figures 3 through 7, the lines showing strata breaks between two borings are based on linear interpolation and the actual depth/elevation of any stratum between two borings could be different from what is shown on the profiles.

The subsurface profiles at the site can be generally characterized as a surficial layer of fill underlain by a natural soil profile consisting of residual soils underlain by partially weathered rock (PWR) and parent bedrock. However, at some locations, no fill soils were encountered, and at some locations no PWR was encountered above rock. Also, alluvial soils were encountered above residual soils along the proposed force main alignment in the flood plain area east of Cheshire Bridge Road. Generalized discussions of the soil types encountered at various locations within the project site are presented in the following paragraphs. For the purpose of this discussion, partially weathered rock (PWR) is characterized for engineering purposes as residual soils exhibiting N-values in excess of 50 blows for 6 inches of penetration. Auger refusal is indicative of the top of parent bedrock.

4.2.1 Equalization Tank

Borings B-1 through B-9 were drilled near/within the currently selected footprint of the equalization tank, as shown in Figure 2. Asphalt pavement and base materials were initially encountered at these borings and the pavement system thickness ranged from 11 to 24 inches. Below the pavement, these borings encountered 10 to 20 feet of fill soil consisting of silty sands and sandy clays with organics including stumps, roots, and other plant remains. Underlying the fill, residual soils, typically silty sand and sandy silt, were encountered to depths varying from 26 to 42 feet below the existing grades. SPT N-values in the fill ranged from 2 to 18 blows per foot (bpf), and the SPT N-values in the residuum ranged from 1 to 47 bpf.

Underlying the residual soils, a layer of partially weathered rock (PWR), sampled as very dense silty sand, was encountered eight of the borings. Layer thickness of PWR varied from 2 to 18 feet with SPT N-values varying from 50 blows for 6-inches to 50 blows for 0-inch.

Auger refusal, indicating the top of weathered rock/rock, was encountered at eight borings. The depth to auger refusal varied from 28 to 57 feet below the existing grades. The auger refusal elevation ranged from 818 to 780 feet. Boring B-7 was terminated in PWR at 60 feet below the

existing ground surface, elevation 778 feet without encountering auger refusal. In borings B-3, B-5, and B-9 where auger refusal was encountered, the underlying rock was cored. The core recovery ranged from 23 to 91 percent, and the rock quality designation ranged from 8 to 66 percent.

4.2.2 Jack and Bore Tunnel

The proposed force main alignment will extend 300 feet under Cheshire Bridge Road, and a jack and bore installation technique will be used to install the force main under the roadway. Two borings (B-13B, and B-14) were performed for the Jack and bore tunnel section.

Boring B-13B was drilled along the tunnel section of the alignment off Cheshire Bridge Road in the parking lot of an auto mechanic shop (see Figure 2). Asphalt pavement and base materials were encountered at this location, and the pavement system thickness is about 6 inches. Below the pavement system, the boring encountered fill soil consisting of possible construction debris and organics, residuum, and PWR. The tunnel invert elevation at this location is about 840 feet, and fill soils consisting of clayey sand with trace organics were encountered at this location at depth in our boring.

Boring B-14 was drilled near the east end of the proposed jack and bore tunnel section (see Figure 2). The boring encountered fill soil, residuum, and PWR. The tunnel invert elevation at this location is about 831 feet, and residual soils consisting of sandy silt was encountered at this depth.

As indicated earlier, borings B-11 and B-38 (see Figure 2) were drilled to evaluate alternative alignments of the tunnel crossings under Cheshire Bridge Road. Borings B-11 and B-38 encountered 12 to 14 feet of fill consisting of loose to medium dense silty sand and highly organic soil with leaves and decaying plant matter. Underlying the fill soils, residual soils were encountered, typically consisting of silty sand, sandy silt, and clayey sand. Under the fill and residual soils PWR was encountered, extending to the auger refusal depth of 40 feet.

4.2.3 Equalization Pump Station

An equalization pump station will be constructed adjacent to the equalization tank. The pump station is approximately 56 feet by 74 feet in plan dimensions and the foundation level of the pump station is about 57.75 feet below the ground surface at an elevation of 783.5 feet. Borings B-4 and B-5 were drilled near the proposed pump station (see Figure 2). Asphalt pavement and base materials were encountered at these locations, and the thickness of the pavement system ranged from about 18 to 24 inches. Below the pavement, these borings encountered 10 to 15.5 feet of fill soils typically consisting of very loose to loose silty sand with debris and trash such as glass, crushed concrete, and organics, with SPT N-value ranging from 2 to 8 bpf.

Underlying the fill soils, 20 to 25 feet of residual soils were encountered. The residual soils consisted mostly of very soft to very stiff sandy silt with SPT N-values ranging from 1 to 35 bpf. Below the residual soil, PWR was encountered. PWR layer thickness ranged from 12 to 15 feet. The SPT N-value in the PWR ranged from 50 blows for 6-inches to 50 blows for 1 inch of penetration. At the proposed pump station bottom elevation of 783.5 feet, PWR is expected.

Groundwater was encountered at elevations ranging from about 819 to 825.5 feet, 36 to 42 feet above the bottom elevation of the pump station.

4.2.4 Force Main Alignment

Borings performed for the entire force main alignment include nine borings (B-13A, B-13B, B-14, B-24, B-28, B-27, B-25, B-39, and B-40) were performed near/along the force main alignment. It is our understanding that a trench excavation method will be used to install the force main.

At the invert elevations along this portion of the force main alignment, the soil types are expected to vary from PWR at B-25 to soft alluvium at Diversion Structure #2. Borings B-13B and B-14 were drilled along the jack and bore tunnel portion of the alignment and B-25 and B-39 were drilled for the diversion structure pump station and Diversion Structure #2. The soil types encountered at theses borings are described in the respective sections. Soil types encountered at the other boring locations along the alignment are described below.

At the proposed invert elevation of about 850.5 feet near B-24, the expected soil is a medium dense silty sand (micaceous) with an SPT N-value of about 18 bpf. At this location, groundwater was encountered at an elevation of about 819 feet, which is substantially below the proposed invert elevation.

At location B-13A auger refusal was encountered at shallow depths ranging from 4.5 to 14 feet at five different locations, indicating possible boulder fill.

Boring B-28 was drilled east of the proposed jack and bore tunnel (see Figure 2). The boring encountered fill soil, residuum, and PWR. At the proposed invert elevation of about 821.5 feet, medium dense silty sand is expected, with an SPT N-value of 24. At this location, groundwater was encountered at an elevation of 815 feet, i.e., about 6 feet below the proposed invert elevation.

At the proposed elevation of about 815 feet near boring B-27, the boring encountered medium dense clayey sand with an SPT N-value of 13. Groundwater was encountered at an elevation of 805.5 feet, which is 10 feet below the proposed invert elevation.

At the proposed invert elevation of 794 feet near B-25, the expected soil is PWR with an SPT N-value of 50 blows for 5 inches of penetration.

4.2.5 Diversion Pump Station and Associated Structures

Near the east end of the alignment, structures including a pump station, electrical building, odor control structure, and transformer pad are proposed. For these structures, borings B-26 and B-39 were drilled adjacent to/within the proposed footprint. B-26 was drilled for a previous force main alignment and is approximately 70 feet away from the structures. Boring B-26 encountered 6 feet of possible fill from the sewer easement consisting of firm to soft sandy clay. Below the possible fill, this boring encountered 6 feet of alluvial soils, typically sandy clay or clayey sand, with SPT N-values ranging from 3 to 7 bpf. Underlying the alluvial soils, 7 feet of residuum consisting of silty sand was encountered with a SPT N-value of 55. Below the residual soil a

PWR layer extended from a depth of 19 feet to the boring termination depth of 24 feet below the existing ground surface. The SPT N-value in the PWR was 50 blows for 3 inches of penetration. Groundwater was encountered at an elevation of 806 feet.

Boring B-39 was drilled in the northeast corner of the building footprint. Residual soils consisting of sandy clay and silty sand were encountered to a depth of 10 feet. The SPT N-value of the residual soil ranged from 20 to 55 bpf. Underlying the residual soils a 2-foot layer of PWR was encountered. The PWR was a silty sand with SPT N-value of 50 blows for 4 inches of penetration. Auger refusal was encountered at 11.5 feet below the existing ground surface. The underlying rock was cored to a depth of 21.5 feet. The core recovery was 65% and the rock quality designation was 17%.

4.2.6 Diversion Structures

The new diversion structures will be constructed at the existing South Fork Peachtree Creek Relief Sewer at the eastern end of the project site. Diversion Structure #1 located east of Peachtree Creek and Diversion Structure #2 is located approximately 50 feet south of the proposed diversion pump station.

Boring B-40 was drilled adjacent to the footprint of Diversion Structure #1. The boring encountered 8 feet of possible fill material from the sewer easement consisting of silty sand and gravel with SPT N-values ranging from 19 to 8 bpf. Below the fill, an alluvial layer consisting of sandy clay and silty sand was encountered to a depth of 18.5 feet. Underlying the alluvial soil, PWR was encountered to a depth of 23 feet. The SPT N-value in the alluvial soil ranged from 2 to 10 bpf, and in PWR it ranged from 50 blows for 4 inches to 50 blows for 0 inches of penetration. Auger refusal was encountered at 23 feet and rock was cored to a depth of 33 feet. The rock recovery was 97% and the rock quality designation was 33%.

4.3 Site Environmental Assessment

Willmer performed a Phase I environmental assessment for this site. Also, during drilling at borings locations B-1 and B-2 in the tank area, a hydrocarbon smell (possibly gasoline) was encountered in samples obtained from depths of about 12 to 28 feet. Temporary piezometers were placed in these borings. ASG was informed of potential soil and/or groundwater impacts and Willmer was subsequently authorized by ASG to sample the ground water from the piezometers and submit the samples for analyses of petroleum hydrocarbons. Results of this soil and groundwater exploration and the Phase I environmental assessments were provided under separate reports.

5.0 Geotechnical Engineering Evaluation and Recommendations

5.1 General

The geotechnical engineering evaluation and recommendations presented herein are based on the soil boring, rock coring, and laboratory test data gathered during this exploration, our understanding of the proposed construction, and our experience with similar site and subsurface conditions and structures. These recommendations were prepared in accordance with generally accepted geotechnical engineering practice for the exclusive use of ASG, the City of Atlanta, and their designated consultants for use in the design of the proposed Liddell Drive Equalization project. No other warranty, expressed or implied, is made. This report should not be relied upon by other third parties.

We request that we be advised of any changes in the proposed development from that described in this report so that we may amend our recommendations accordingly. In addition, we request the opportunity to review the portions of the project specifications that relate to geotechnical engineering to ensure that our recommendations are properly incorporated.

5.2 Site Preparation

A portion of the area for the proposed construction is located in an urbanized setting. Many buried and overhead utilities will likely be encountered in the tank area and on either side of Cheshire Bridge Road during construction. Disruption to traffic and local businesses will also likely be a major impact. The construction work will need to be coordinated with all parties to minimize disruption.

Site and subgrade preparation should begin with the removal of all trees, surface vegetation, organic-laden soils, topsoil, and any uncontrolled fill materials within the proposed construction area. All existing miscellaneous debris fill in the equalization tank area and the unsuitable soft alluvial soils encountered along the force main alignment should be removed and disposed offsite. In the existing pavement areas, all asphalt/concrete including aggregate base materials below the pavements should be removed from the proposed construction areas. If the aggregate base material can be removed without substantial contamination by organics, it may be reused as engineered fill.

5.3 Difficult Excavation

At a number of locations, excavation of PWR and/or rock will be required to achieve design grades. These locations are summarized below:

Location	Boring Number	Excavation
Equalization Tank	B-1	PWR and Rock
	B-2	PWR and Rock
	B-3	PWR and Rock
	B-5	PWR
	B-9	PWR and Rock

Equalization Pump Station	B-4	PWR
	B-5	PWR and Rock
Force Main Alignment	B-25	PWR
Diversion Pump Station	B-26	PWR and Rock
	B-39	PWR and Rock

We recommend that the following general guidelines be used in the excavation specifications for this project:

The soil overburden (existing fill, alluvial, and residual soil) can be removed by conventional excavation equipment such as large backhoes. On the boring summary (Table 1), this is the material overlying the PWR and refusal level in the borings.

PWR and fractured/weathered rock would likely be rippable with heavy excavation equipment such as a D-8 dozer with single ripper claw attachment, or a CAT 330 or equivalent trackhoe. Material that cannot be removed by such equipment may have to be jack-hammered out with a hydraulic jack hammer attached to a trackhoe. Hard rock will likely require blasting for removal. The following definitions can be used to clarify material excavation techniques and equipment capabilities:

1) Rip Rock: Any material that cannot be moved by scrapers, loaders, pans, or graders and that requires the use of a single-tooth ripper mounted on a crawler tractor having a minimum draw bar pull rated at not less than 56,000 pounds.

2) Blast Rock (General Excavation): Any material which cannot be excavated with a single-tooth ripper mounted on a crawler tractor having a minimum draw bar pull rated at not less than 56,000 pounds (Caterpillar D-8K or equivalent) or by a Caterpillar 977 front-end loader or equivalent, and occupying an original volume of at least one cubic yard.

3) Blast Rock (Trench Excavation): Any material which cannot be excavated with a backhoe having a bucket curling force rated at not less than 25,700 pounds (Caterpillar Model 225 or equivalent), and occupying an original volume of at least one half cubic yard.

In evaluating site grading and excavation requirements, it must be noted that subsurface conditions, particularly the location and elevation of rock, whether in boulders or massive form, can vary erratically in the Piedmont Physiographic Province in which this site is located. Therefore, there is always a possibility that rock may be encountered at shallower depths in unexplored areas. If large boulders or massive rocks are encountered during the grading operations, blasting may be necessary to facilitate removal.

5.4 Temporary Bracing for Excavation

5.4.1 Force Main, Diversion Pump Station, and Diversion Structures

Due to the urban conditions along the proposed alignment, we recommend that a temporary shoring system be installed or trench boxes be used where required to permit excavation for the

proposed force main. Excavation for the pipeline alignment is anticipated to be rectangular in shape. The choice of excavation support (steel sheet pile, trench box, etc.) will be the option of the contractor, subject to review by the design engineer. Sheet piling may be required in some areas to protect adjacent buried utilities or property. Open excavation can be considered where sufficient space is available for a safe side slope. Depending on the site constraints, a combination of open excavation on one side and braced excavation on the other can also be considered at some locations. All excavations should be performed in accordance with OSHA regulations for Occupational Safety and Health Standards - Excavations (29 CFR Part 1926). The excavation should be carefully monitored and further flattening of slopes will be required if significant sloughing occurs.

5.4.2 Equalization Tank and Pump Station

Special consideration will be required in the design and construction of excavation supports for installation of the equalization tank due to the presence of near surface uncontrolled miscellaneous debris fill in this area which could cause difficulty in installation. Sheet piles will be difficult to vibrate through the debris fill. H-piles for excavation support will also likely encounter refusal in the debris fill. As such, the debris fill should be excavated (i.e. with a sloped open excavation) where possible prior to installation of the excavation support system for the tank. Once the debris fill is removed either sheet piles or H-piles and lagging can be installed to achieve support in the materials below the debris fill. Adequate embedment into PWR/rock and/or tie-back anchors will be required for stability of the excavation support system.

5.5 Drainage and Groundwater Management

Good site drainage must be provided during the construction phase. All ground surfaces must be sloped to prevent the ponding of surface water adjacent to the proposed excavations. Groundwater was encountered at or above the anticipated pipe invert or tank bottom elevations at seven locations. These locations are summarized below:

Boring Number	Location	Bottom/Invert Elevation (ft)	Water Elevation (ft)
B-1	Equalization Tank	Perimeter: 802 Conical Base: 794.5	826
B-2			823
B-3			836
B-4			819
B-5			826
B-6			822
B-7			819
B-8			817
B-9			821
B-4	Equalization Pump Station	783.5	819
B-5			816.7

B-26	Diversion Pump Station	781	806
B-40	Diversion Structure #1	792.5	806
B-26	Diversion Structure #2	791.5	806

Groundwater was encountered in the above borings at the time of drilling at elevation ranging from 802 to 836 feet, as shown above. At the time of construction, water levels may be different from the presently observed levels. Groundwater will need to be lowered to allow excavation for these structures. Dewatering may be accomplished by pumping from sumps within the excavation. Alternatively, a dewatering system consisting of well points may be required around the outside perimeter of excavations to lower the groundwater prior to the start of excavation. In addition, dewatering will be required to permit trench excavation for the pipe alignment to permit excavations in dry conditions and avoid further softening of bearing soils.

In the event dewatering well points are used to control groundwater along any particular segment of the alignment, the drawdown of the groundwater may cause settlement and possible damage to adjacent underground utilities and other structures. If well points are to be used, the effect of the drawdown will need to be evaluated to determine potential impacts to buried utilities on adjacent structures. It should also be noted that groundwater levels are subject to seasonal and climatic changes.

In addition, a low area with ponded water was observed near the east end of the force main alignment during one of our field visits. This area will need to be drained or separated from the alignment by a berm prior to beginning excavation for the pipe trench.

5.6 Engineered Fill Placement

Structural fill will be used to replace undercut materials, achieve finished grades, or backfill around the proposed tank, pump stations, diversion structures, and pipelines. Existing fill soils may be re-used as structural fill provided the material is free of debris and organics and is not highly micaceous. At locations along the alignment, debris and rock were encountered in the fill. This material should not be re-used. Also, any alluvium should not be reused. Debris laden fill and alluvium should be wasted.

All structural fill used on site should be free of significant organic matter or debris, have a low to moderate plasticity (liquid limit less than 50 percent and plasticity index less than 30 percent), exhibit uniform composition, and be free of rock fragments greater than three inches in diameter. Soils selected for use as engineered fill material should also have a standard Proctor (ASTM D 698) maximum dry density of at least 90 pounds per cubic foot (pcf). It is recommended that bulk soil samples along the alignment be obtained and tested for compliance with this recommendation.

The engineered fill must be brought to the proposed subgrade elevation by placing and compacting only approved fill materials upon a subgrade approved by the geotechnical engineer. Compaction of engineered fill must be accomplished by placing the fill material in

horizontal lifts of four inches until above the pipe, then eight inches maximum loose thickness and mechanically compacting each lift to at least the specified minimum dry density. The newly placed engineered fill must be uniformly compacted to a dry density that corresponds to at least 95% of the standard Proctor maximum dry density (ASTM D698) of the fill soil. Under roadway/pavement areas, we recommend that the final 12-inches below pavement subgrade be compacted to 98% of the standard Proctor maximum dry density (ASTM D698) of the fill soil before replacing pavement section materials (GAB and asphalt).

To achieve the requirement for dry density, the newly placed engineered fill must be placed at a moisture content that corresponds to ±3% of the optimum moisture content, as determined by the Standard Proctor moisture-density relationship test. During wet and rainy periods, aeration (drying) is often necessary to reduce the fill materials to the required moisture condition.

During dry periods, water may need to be added to achieve the proper moisture content for compaction. Silty soils, which are wet, may require aeration prior to compaction even during dry periods. Proper drying would involve spreading the overly wet soil over a large area to allow the sun to evaporate some moisture in addition to continuously turning the soil over. Within the proposed alignment this does not appear to be viable due to the urban nature of the site. As alternatives to natural aeration to dry the excavated soils, blending with dryer soil and lime or cement treatment may be considered to lower the moisture content close to optimum moisture conditions for compaction purposes. We recommend that all fill placement be witnessed by a qualified soils technician and that density and moisture tests be performed at a minimum frequency of one test per 100 yd^3 of fill placed to verify that the specified compaction is achieved.

5.7 Pipe Bedding

The soil conditions vary along the proposed force main alignment. In the areas where soft alluvial soils are encountered, the alluvium should be undercut and replaced with compacted No. 57 stone at the discretion of the project geotechnical engineer. In addition, in order to provide uniform support throughout and minimize differential settlement of the pipe, PWR/rock should be undercut by at least two feet and replaced with No. 57 stone. This will minimize non-uniform support conditions in the transition area from PWR/rock to soil and minimize the possibility of overstressing the pipe.

Also, as indicated earlier, the force main alignment west of Cheshire Bridge Road was revised recently after completion of our field exploration program, and no subsurface information is available for the force main alignment between B-13B and the equalization tank. It is recommended that additional geotechnical exploration be performed in this area to characterize the existing subsurface conditions that may impact design and construction. This information is critical for obtaining representative construction bids.

5.8 Jack and Bore Tunnel

Based on the two borings (B-13B and B-14) performed for the jack and bore tunnel section, the installation will extend through mixed soil conditions consisting of fill and residual soils. Groundwater was not encountered above the pipe invert in the borings performed along this section.

5.9 Foundation Recommendations

5.9.1 Equalization Tank

As indicated earlier, the elevation of the top of rock at the tank location is expected to range from 794 to 817.5 feet, and the elevation of the top of PWR ranges from about 795 to 817 feet. The tank bottom elevation ranges from approximately 794.5 to 802 feet. Based on the boring data, the tank bottom is expected to be underlain by a combination of residual soils, PWR, and rock. On the southwestern side, the tank bottom will likely be underlain directly by rock. On the northern and eastern sides, the tank bottom will likely be underlain by residual soils and PWR above rock.

Based on the subsurface conditions described above, we recommend that the tank bottom be supported directly on PWR/rock. Up to 6 feet of residual soils may be encountered in some parts of the tank footprint. We recommended that the residual soils be undercut to top of PWR and replaced with compacted GAB.

Alternately, a combination of deep foundation and tank bottom bearing directly on rock can be used. In areas where rock is encountered at the tank bottom elevation, the tank bottom will bear directly on rock. Deep foundations will be used in areas where residual soils or PWR are encountered above rock.

5.9.2 Deep Foundation Support for Equalization Tank

As recommended above, deep foundations can be used in areas where residual soils and/or PWR are encountered above rock below the tank bottom. Auger-cast piles are recommended as the deep foundation for this project.

An allowable capacity of 120 tons can be achieved with 16-inch diameter auger-cast piles installed to rock (i.e., drilling refusal). However, for piles shorter than 15 feet, we recommend an allowable capacity of 75 tons per pile. Smaller diameter piles with lower capacities and larger diameter piles with higher capacities can also be used. However, friction auger-cast piles are not recommended for this project because of inadequate thickness of PWR above the bearing level and the relatively low-strength soil profile above PWR/rock.

Unlike driven piles, auger-cast piles can be advanced through soil and PWR with similar levels of effort. Therefore, to ensure adequate capacity, the auger should be advanced through the overburden soils and PWR until practical refusal is encountered.

If auger cast piles are used, we recommend that several probe piles be installed and a compression load test be performed prior to production pile installation. The probe piles and the test pile should be used to establish installation procedures including speed of withdrawal and number of strokes and corresponding volume of grout being pumped during withdrawal. A Willmer geotechnical engineer should observe the installation procedures and load test and mutually agree with the pile contractor on the installation methods, guidelines, and load test results. The load test pile should be able to carry at least twice the design load without

excessive deflection. Installation of production piles should begin only after successful completion and acceptance of the load test by the geotechnical and structural engineer.

A minimum center-to-center spacing of 4 feet is recommended for the 16-inch diameter auger-cast piles. Contiguous piles should not be installed before initial set of the adjacent pile to avoid any possible connection of wet concrete between the piles. For long piles, there is a risk of piles being closer at the tip level than the minimum design spacing at the cap level. Therefore, special attention should be directed towards spacing and plumbness during pile installation.

Auger-cast piles require continuous removal of soil spoils excavated by the pile rig. This will result in some additional overall cost to the project. Because auger-cast piles can be monitored only by indirect means, a very "tight" set of specifications are generally required.

5.9.3 Shallow Foundation Support for Equalization Tank

As recommended in Section 5.9.1, the tank bottom will bear directly on PWR/rock depending on the chosen foundation option. Allowable bearing pressures of 10 and 20 ksf are recommended for PWR and rock, respectively. All subsurface should be inspected by the project geotechnical engineer to confirm suitable bearing conditions. The geotechnical engineer will determine the areal extent of the tank bottom area where piles are not required. If rock is over-excavated during construction, lean concrete should be used to fill fractures and create a uniform mat for supporting the tank bottom.

5.9.4 Equalization Pump Station

The foundation base level for the pump station, at elevation 783.5, is expected to be in PWR and rock. Allowable bearing pressures of 10 and 20 ksf are recommended for PWR and rock, respectively. All subsurface conditions should be inspected by the project geotechnical engineer to confirm suitable bearing conditions.

5.9.5 Uplift Resistance for Equalization Tank

The groundwater elevations in the equalization tank area are above the tank bottom elevation. Groundwater levels are subject to seasonal and climatic changes. Therefore, the tank will be subjected to hydrostatic uplift pressure. A portion of the uplift pressure will be balanced by the dead weight of the tank/pump station. Rock anchors can be used to provide additional uplift resistance.

Rock anchors installed through auger-cast piles can be used to provide uplift capacities for these piles. Based on our experience with the rock anchors and rock anchor load tests performed recently in similar rock, an uplift capacity of 15 kips can be obtained with 3-inch diameter anchors embedded 10 feet into rock. These anchors consisted of 1-inch diameter reinforcing steel bars grouted in 3-inch diameter holes. Longer/larger diameter anchors can be designed to achieve higher load capacities. If used, all anchors should be proof-tested to 150 percent of the design load.

In areas where the tank bottom will bear directly on rock/PWR, rock anchors can be installed directly from and tied to the tank bottom mat to provide uplift capacities. Based on our

experience with rock anchors and rock anchor load tests performed recently in similar rock, an uplift capacity of 130 kips can be obtained with 6-inch diameter anchors embedded 16 feet into rock. These anchors consisted of $1^3/_8$-inch diameter reinforcing steel bars grouted in 6-inch diameter holes. Longer/larger diameter anchors can be designed to achieve higher load capacities. If used, all anchors should be proof-tested to 150 percent of the design load.

5.9.6 Diversion Pump Station and Associated Structures

Borings B-26 and B-39 were drilled near/within the proposed building footprint of the diversion pump station. The pump station will have upper and lower foundation base levels. The base level elevations for the structure range from 781 (lower) to 804 (upper). At the base level the soil condition expected is to be predominantly PWR and rock. Allowable bearing pressures of 10 and 20 ksf are recommended for PWR and rock, respectively. All subsurface should be inspected by the project geotechnical engineer to confirm suitable bearing conditions. If rock is over-excavated during construction, lean concrete should be used to fill fractures and create a uniform mat for supporting diversion pump station bottom. A portion of the pump station foundation may be located in a soft alluvial layer. This compressible alluvial layer is expected to underlie the upper level of the pump station and should be removed and replaced with compacted engineered fill or GAB during construction. Approximately 5 feet of undercut will likely be required in some portions of the pump station footprint.

5.9.7 Diversion Structures

Along the eastern end of the alignment, two diversions structures (#1 and #2) will tie the proposed pipeline into the existing relief sewer. The diversion structures will be constructed with an upper level, for tie-in to the existing sewer, and a lower level, for flow to the proposed pipeline. Borings B-26 and B-40 were drilled near the proposed footprint of diversion structures #1 and #2, respectively. At both diversion structures, a soft alluvial layer was encountered to elevations from 799 to 794 feet. This compressible alluvial layer is expected to underlie the upper level of the diversion structure and existing pipe and should be removed and replaced with compacted engineered fill or GAB during construction. Approximately 5 feet of undercut will likely be required at each diversion structure. The foundation level of the lower level is expected to be in partially weathered rock. An allowable bearing pressure of 10 ksf is recommended for PWR. All subsurface should be inspected by the project geotechnical engineer to confirm suitable bearing conditions.

5.9.8 Uplift Resistance for Pump Stations and Diversion Structures

The groundwater elevations at the pump stations and the diversion structures are above the foundation bottom elevation. These structures will be subjected to hydrostatic uplift pressure. A portion of the uplift pressure will be balanced by the dead weight of the individual structure. Rock anchors can be used to provide additional uplift resistance.

Rock anchors can be installed directly from and tied to the bottom of the structure to provide uplift capacities. Based on our experience with rock anchors and rock anchor load tests performed recently in similar rock, an uplift capacity of 130 kips can be obtained with 6-inch diameter anchors embedded 16 feet into rock. These anchors consisted of $1^3/_8$-inch diameter reinforcing steel bars grouted in 6-inch diameter holes. Longer/larger diameter anchors can be

designed to achieve higher load capacities. If used, all anchors should be proof-tested to 150 percent of the design load.

5.10 Lateral Earth Pressure for Temporary Bracing

The temporary bracing systems for the force main excavations, jack and bore tunnel pits, tank area excavations, diversion pump station and associated structures, and the diversion structures will be designed for lateral earth pressure. The earth pressure distribution will depend on the type of wall and the bracing or tie-back anchors used. Active earth pressure distribution should be used for sheet pile walls. It should be noted that groundwater was encountered in some borings along the force main alignment. If the groundwater is drawn down using a dewatering system, there will be no lateral pressure due to groundwater.

Based on the soil types encountered at this project, the following general soil parameters are recommended for design of bracing system:

• Friction Angle for Soil	25 degrees
• Active Earth Pressure Coefficient (K_a)	0.41
• At-rest Pressure Coefficient (K_0)	0.58
• Passive Earth Pressure Coefficient (K_p)	2.5*
• Unit Weight of Soil as Placed	120 pcf
• Equivalent Active Fluid Pressure	49 pcf
• Equivalent Passive Fluid Pressure	300 pcf*
• Equivalent At-rest Fluid Pressure	70 pcf
• Coefficient of Sliding Friction	0.30*

* In the design calculations, the resisting forces computed using the above recommended passive earth pressure coefficient, equivalent passive fluid pressure, and coefficient of sliding friction should be reduced using a safety factor of 1.5.

In addition to the lateral earth pressure from the soil behind the bracing system, a uniform surcharge pressure of 500 psf should be added to account for construction equipment loading and/or surcharge due to stockpiled soil near the top of the braced excavation.

5.11 Lateral Earth Pressure for Walls of Structures

The walls of the equalization tank, pump stations, and diversion structures will be designed for lateral earth pressures from the backfill materials behind the walls. Since these will be rigid structures, active earth pressure condition will not develop in the backfill materials behind the walls; therefore, higher at-rest earth pressures should be used for design of the walls. Groundwater was encountered in the borings above bottom elevations of the structures. It should also be noted that groundwater levels are subject to seasonal and climatic changes. Therefore, hydrostatic pressures must be added to the effective earth pressures to obtain the design lateral pressure for the walls.

It is recommended that granular soils with a minimum fiction angle of 32 degrees be used as backfill behind the tank walls, and the granular backfill should be compacted to at least 95

percent of the Standard Proctor (ASTM D 698) maximum dry density. The following parameters are recommended for tank wall design:

• Friction Angle for Granular Backfill	32 degrees
• Active Earth Pressure Coefficient (K_a)	0.31
• At-rest Pressure Coefficient (K_0)	0.5
• Passive Earth Pressure Coefficient (K_p)	3.0*
• Unit Weight of Granular Soil as Placed	125 pcf
• Equivalent Active Fluid Pressure	40 pcf
• Equivalent Passive Fluid Pressure	375 pcf*
• Equivalent At-rest Fluid Pressure	65 pcf

* In the design calculations, the resisting forces computed using the above recommended passive earth pressure coefficient and equivalent passive fluid pressure should be reduced using a safety factor of 1.5.

5.12 Seismic Site Classification

The seismic site class for the proposed tank area was determined in accordance with the procedures outlined in Section 1613 of the 2009 International Building Code (IBC). The seismic site class was determined using the SPT N-values in borings B-1 through B-9 performed at the tank location.

The weighted average N-value within the top 100 feet of the subsurface profile was calculated in accordance with the procedures outlined in Section 1613.5.5 of IBC. Partially weathered rock and rock were encountered within the top 100 feet at the boring locations. In accordance with IBC guidelines, these materials were assigned an SPT N-value of 100 blows/foot. Based on the subsurface profile within the top 100 feet, the site was classified as Site Class D.

5.13 Design Response Spectrum

As outlined in Section 1613.5.1 of IBC, the design spectral response acceleration parameters for short periods and 1-second period were determined based on the site class described above, the contour maps of maximum considered earthquake ground motion in Figures 1613.5(1) and 1613.5(2), and the procedures outlined in Sections 1613.5.3 and 1613.5.4 of IBC. Based on Site Class 'D', the design spectral response accelerations were computed as follows:

Short Periods Acceleration, S_{DS}	= 0.267g
1-second Period Acceleration, S_{D1}	= 0.144g

A design response spectrum curve constructed using the above acceleration values is presented in Figure 8 for use in design.

6.0 Geotechnical Engineering Oversight During Construction

The recommendations provided herein are based on the geotechnical information gathered for the site, our interpretation of the available data, and our experience with similar soils and similar projects in the Atlanta area. Geotechnical recommendations cannot be considered complete until the geotechnical engineer has the opportunity to confirm the subsurface conditions by performing actual field observations during construction. It is critical that our engineering staff provide inspection during subgrade preparation, backfill compaction, and foundation installation. We recommend that Willmer be retained to provide geotechnical engineering oversight during construction to confirm that the recommendations provided herein are properly interpreted and implemented. We look forward to providing these services during construction of the project, as well as construction monitoring and material testing. Geotechnical oversight and material testing for this project will include:

- Subgrade bearing verification
- Tank rock anchor proof testing verification
- Observation of undercutting and replacement
- Backfill compaction
- Sampling and testing of fresh concrete

TABLES

Table 1

Summary of Subsurface Conditions
Liddell Drive Equalization Project
Atlanta, Fulton County, Georgia
Willmer Engineering Project No. 71.3801

Boring Number	Ground Surface Elev. (ft)	Groundwater Depth and Elevation (ft)		Depths and Elevations to Top of Layer (ft)										Layer Thickness (ft)			
				Fill		Alluvium		Residuum		PWR[1]		Auger Refusal					
		Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Depth	Elevation	Fill	Alluvium	Residuum	PWR[1]
B-1	844.9	18.5	826.4	2	842.9	--	--	12	832.9	32	812.9	34	810.9	10	--	20	2
B-2	843	20	823	1.5	841.5	--	--	12	831	26	817	31	812	10.5	--	14	5
B-3	845.6	9	836.6	1.5	844.1	--	--	12	833.6	--	--	28	817.6	10.5	--	16	--
B-4	837.2	18	819.2	1.5	835.7	--	--	17	820.2	42	795.2	57	780.2	15.5	--	25	15
B-5	838.3	13	825.3	2	836.3	--	--	12	826.3	32	806.3	44	794.3	10	--	20	12
B-6	834.9	13	821.9	2	832.9	--	--	22	812.9	37	797.9	39	795.9	20	--	15	2
B-7	837.9	19	818.9	1.5	836.4	--	--	17	820.9	42	795.9	--	--	15.5	--	25	18+
B-8	834.7	18	816.7	2	832.7	--	--	12	822.7	34	800.7	45	789.7	10	--	22	11
B-9	840.8	20	820.8	2	838.8	--	--	17	823.8	28	812.8	31	809.8	15	--	11	3
B-10	845	--	--	--	--	--	--	1.5	843.5	12	833	--	--	--	--	10.5	8+
B-11	832.5	11.5	821	0	832.5	--	--	12	820.5	34	798.5	40	792.5	12	--	22	6
B-13A	860	--	--	0.75	859.25	--	--	--	--	--	--	14	846	13.25	--	--	--
B-13B	861.5	--	--	0.5	861	--	--	27	834.5	--	--	42	819.5	26.5	--	15	--
B-14	839.5	--	--	0	839.5	--	--	6	833.5	13	826.5	22	817.5	6	--	7	9
B-15A	818.1	8	810.1	0	818.1	8	810.1	12	806.1	22	796.1	24	794.1	8	4	10	2
B-16	812	3	809	--	--	0	812	5.5	806.5	18	794	--	--	--	5.5	12.5	12+
B-17	813.7	6	807.7	0	813.7	3	810.7	12	801.7	15	798.7	--	--	3	9	3	14+
B-18	813.5	7	806.5	0	813.5	3	810.5	12	801.5	15	798.5	--	--	3	9	3	13.5+
B-19	813	5	808	--	--	0	813	12	801	17	796	20	793	--	12	5	3
B-20	813.5	6	807.5	--	--	0	813.5	--	--	14.5	799	17	796.5	--	14.5	--	2.5
B-21	812.4	6.5	805.9	--	--	0	812.4	17	795.4	28	784.4	--	--	--	17	11	1+
B-22	811.5	6	805.5	0	811.5	3	808.5	14	797.5	--	--	17.5	794	3	11	3.5	--
B-23	811.6	5	806.6	--	--	0	811.6	--	--	14	797.6	--	--	--	14	--	5+
B-24	861	42	819	0.9	860.1	--	--	8	853	18	843	49.5	811.5	7	--	10	31.5
B-25	812.9	8	804.9	0	812.9	6	806.9	--	--	18	794.9	--	--	6	12	--	2+
B-26	811	5	806	0	811	6	805	12	799	19	792	--	--	6	6	7	5+
B-27	817	11.5	805.5	0	817	--	--	3	814	22	795	--	--	3	--	19	7+
B-28	826	11	815	0	826	--	--	3	823	13	813	14.5	811.5	3	--	10	1.5
B-29	841	--	--	0	841	--	--	4.5	836.5	8.5	832.5	11	830	4.5	--	4	2.5
B-30	834	20	814	1.5	832.5	--	--	13	821	18	816	23	811	11.5	--	5	5
B-31	835	17	818	2	833	--	--	12	823	29	806	41	794	10	--	17	12
B-32	837	22.5	814.5	1	836	--	--	6	831	23	814	24.5	812.5	5	--	17	1.5
B-33	831	16	815	1	830	--	--	--	--	22	809	30	801	21	--	--	8
B-34	833	17	816	1	832	--	--	18	815	34	799	43.5	789.5	17	--	16	14.5
B-35	837	18	819	1	836	--	--	13	824	24	813	39.5	797.5	12	--	11	15
B-36	836	17	819	1	835	--	--	21	815	44	792	59	777	20	--	23	15
B-37	844	19	825	1	843	--	--	6	838	18	826	23	821	5	--	12	5
B-38	834	14	820	1	833	--	--	13.5	820.5	33	801	43.5	790.5	12.5	--	24.5	10.5
B-39	816	--	--	--	--	--	--	0	816	10	806	11.5	804.5	--	6	4	1.5
B-40	812.5	10.5	802	0	812.5	8	804.5	--	--	18.5	794	23	789.5	8	5	5.5	4.5

Notes:
1. PWR - Partially Weathered Rock

Table 2

Summary of Laboratory Test Results
Liddell Drive Equalization Project
Atlanta, Fulton County, Georgia
Willmer Engineering Project No. 71.3801

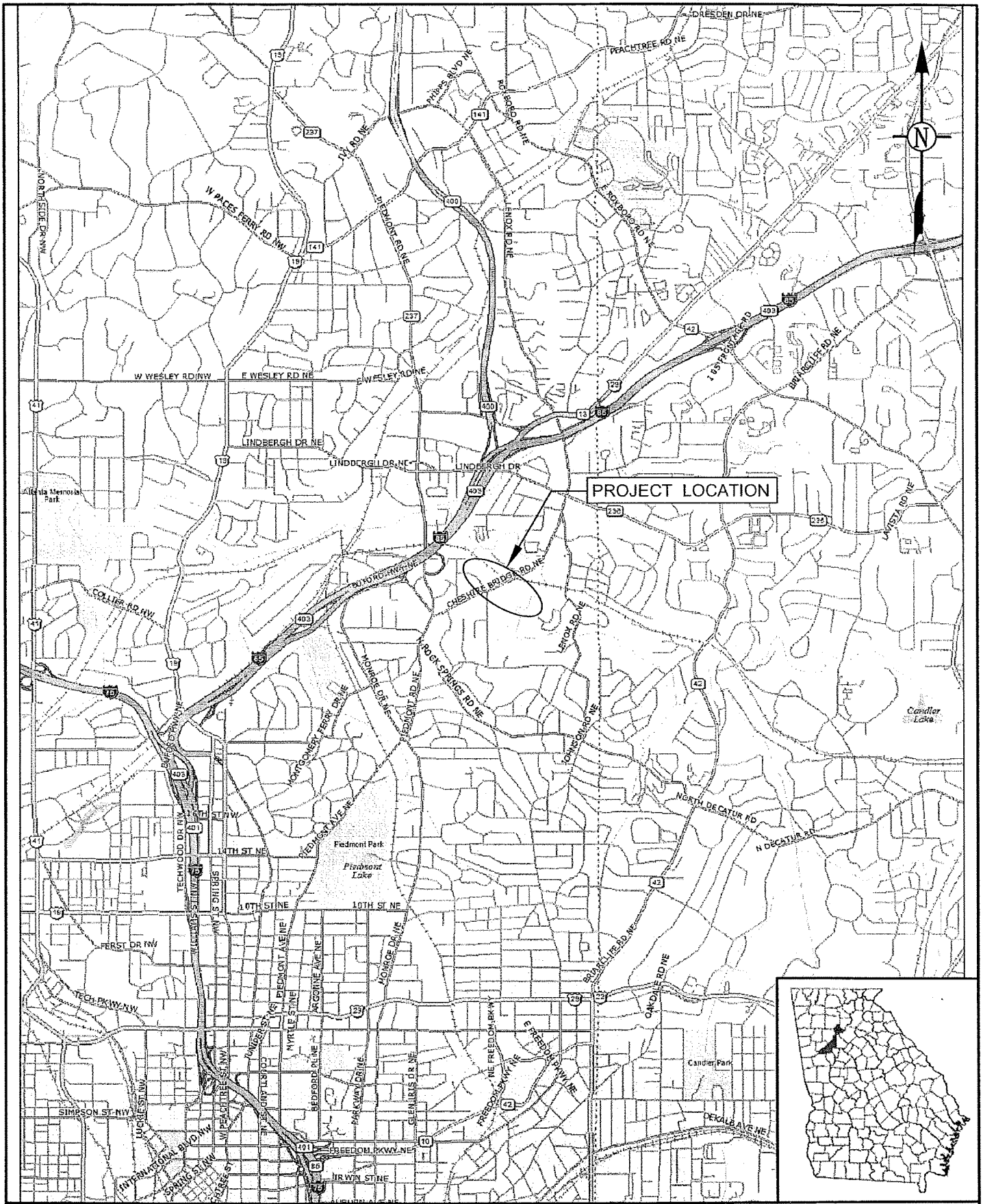
Boring Number	Sample Depth (feet)	Soil Description	Natural Moisture Content (%)	Liquid Limit	Plasticity Index	Percent Fines	Standard Proctor Compaction Test Results		CBR
							Maximum Dry Density (pcf)	Optimum Moisture Content (%)	
B-10	1-5	Brown silty clayey medium to fine SAND	6.3	26	6	40.8	121.3	12	16.7
B-11	18.5-20	Brown silty medium to fine SAND (micaceous)	23.8	31	5	36.5	--	--	--
B-13B	13.5-15	Brown clayey medium to fine SAND (micaceous)	22.6	28	12	49.7	--	--	--
B-15A	3.5-5	Brown fine sandy SILT (micaceous)	36.3	37	8	57.4	--	--	--
B-16	3.5-5	Brown fine sandy SILT (micaceous)	49.4	49	17	52.7	--	--	--
B-17	8.5-10	Grey fine sandy lean CLAY (micaceous)	25.5	25	8	51.5	--	--	--

Table 3

Consolidated-Undrained Triaxial Compression Test Results
Liddell Drive Equalization Project
Atlanta, Fulton County, Georgia
Willmer Engineering Project No. 71.3801

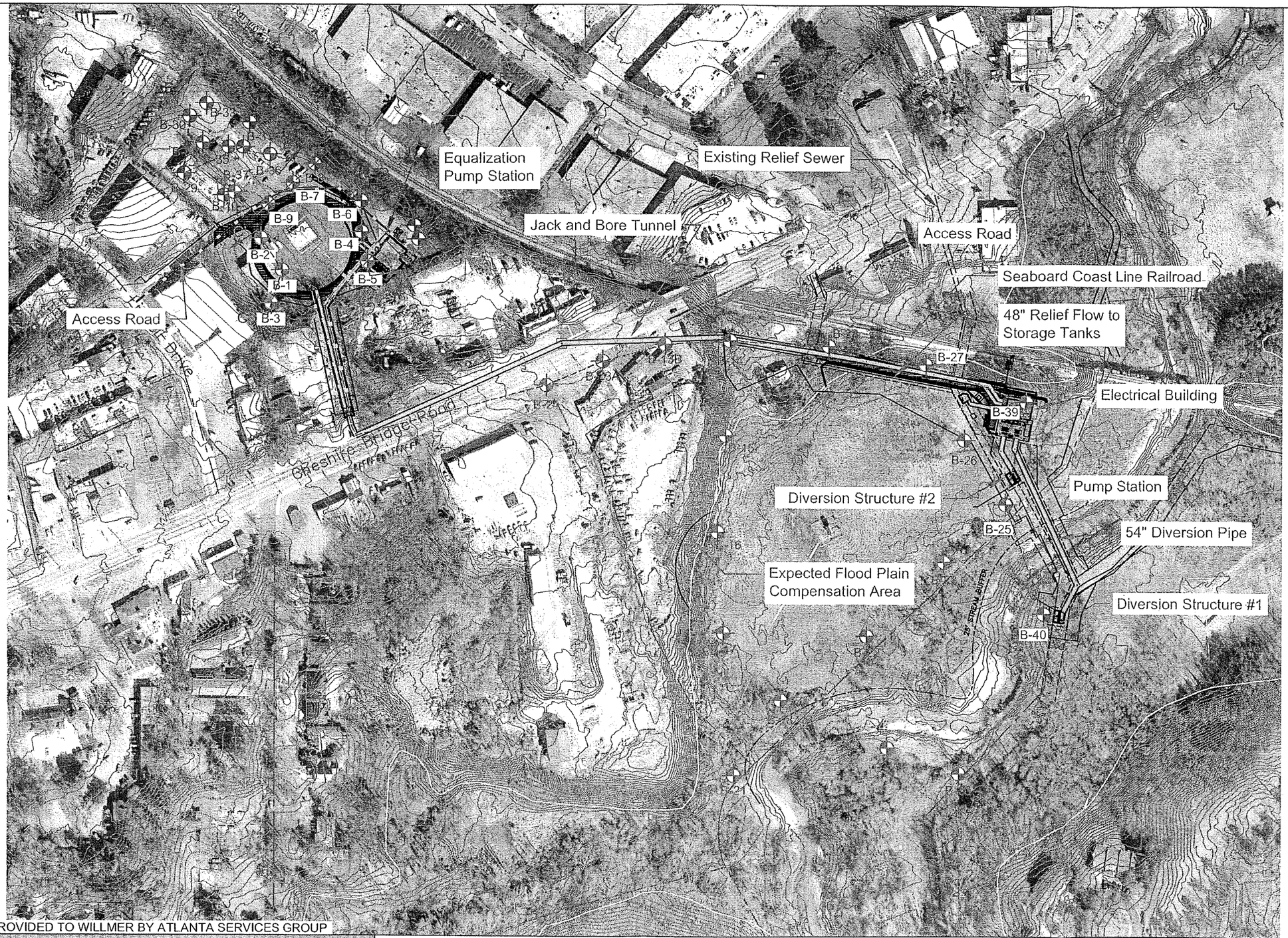
Location	Sample No.	Sample Depth (ft)	Soil Description	Natural Moisture Content (%)	Percent Fines (%)	Dry Density (lb/ft^3)	Effective Consolidation Pressure (lb/in^2)	Effective Stress Strength Parameters	
								Cohesion Intercept, c (lb/ft^2)	Friction Angle, ϕ
B-4 Equalization Tank Area	B-4	25-26.5	Brown silty fine SAND (micaceous)	42.8	31.3	79.5	15	0	24.8°

FIGURES



SCALE: 1" =4000'	GEOTECHNICAL ENGINEERING CONSTRUCTION SERVICES ENVIRONMENTAL SERVICES AND ENGINEERING 3772 PLEASANTDALE ROAD - SUITE 165 ATLANTA, GA 30340-4270	FIGURE 1 PROJECT LOCATION MAP LIDDELL DRIVE EQUALIZATION PROJECT ATLANTA, FULTON COUNTY, GEORGIA WILLMER PROJECT No. 71.3801
SOURCE: DELORME		
DATE: 2/29/12		
DRAWN BY: CDL		
REVIEWED BY: DP		

P:\3801 Peachtree Creek Alternative LD-1\CADD\Project Location Map.dwg



SOURCE: BASE DRAWING PROVIDED TO WILLMER BY ATLANTA SERVICES GROUP

SCALE:	1" = 200'
DATE:	10/9/2012
DRAWN BY:	CDL
REVIEWED BY:	DME

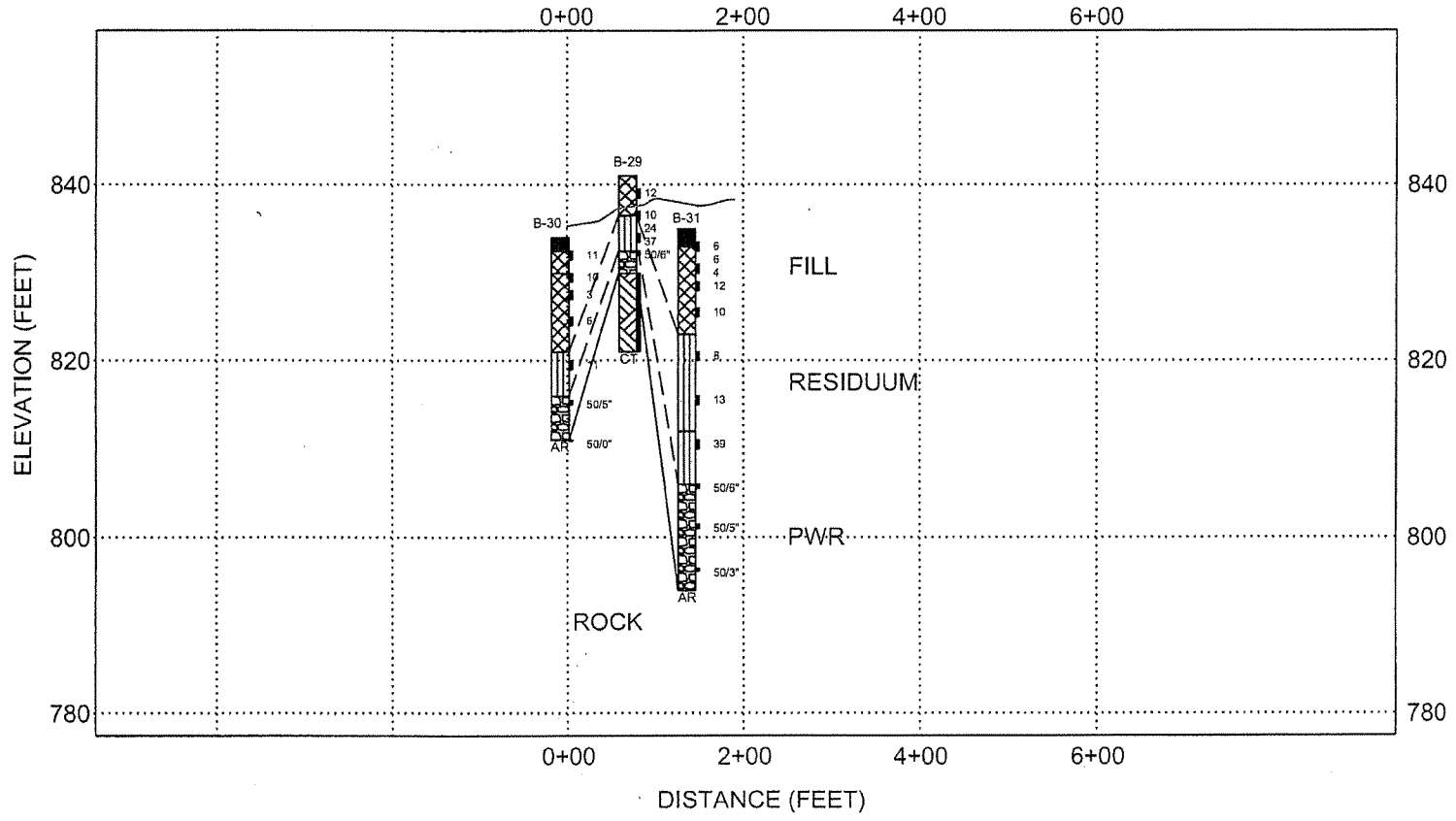
WILLMER ENGINEERING INC. WE

GEOTECHNICAL ENGINEERING ¤ CONSTRUCTION SERVICES
ENVIRONMENTAL SERVICES AND ENGINEERING
3772 PLEASANTDALE ROAD - SUITE 165
ATLANTA, GA 30340-4270

FIGURE 2

BORING LOCATION PLAN
LIDDELL DRIVE EQUALIZATION PROJECT
ATLANTA, FULTON COUNTY, GEORGIA
WILLMER PROJECT No. 71.3801

P:\3801 PEACHTREE CREEK ALTERNATIVE LD-1\CADD\FIGURE 2 - BORING LOCATION PLAN 5.16.12.DWG



NOTES

1. THE APPROXIMATE EXISTING GROUND SURFACE WAS PROVIDED TO WILLMER BY ATLANTA SERVICES GROUP. GROUND SURFACE ELEVATIONS AT THE BORING LOCATIONS WERE ESTIMATED BY INTERPOLATION USING A TOPOGRAPHIC MAP PROVIDED BY ASG.

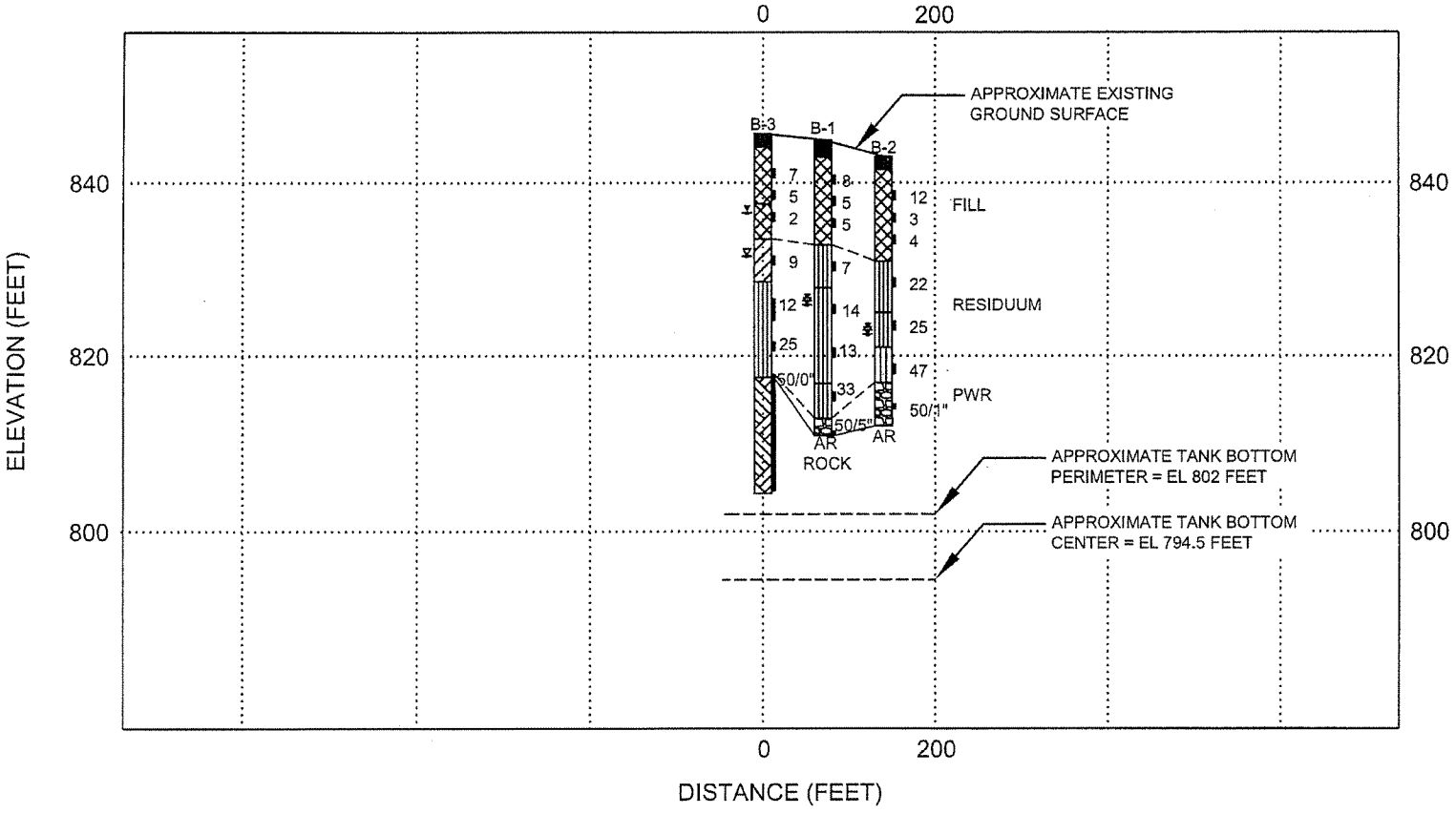
2. THE SOIL STRATIGRAPHY SHOWN ON THIS PROFILE REPRESENTS OUR INTERPRETATION OF THE BORING DATA IN ACCORDANCE WITH GENERALLY ACCEPTED GEOTECHNICAL ENGINEERING PRACTICE. THE LINES SHOWING STRATA BREAKS ARE APPROXIMATE AND BASED ON LINEAR INTERPOLATION BETWEEN BORINGS. THE ACTUAL TRANSITION BETWEEN SOIL STRATA ARE EXPECTED TO BE GRADUAL, AND THE DEPTH/ELEVATION OF ANY STRATUM BETWEEN TWO BORINGS COULD BE DIFFERENT FROM WHAT IS SHOWN ON THIS PROFILE.

SCALE: 1" = 200' H' 1" = 20' V'	WILLMER ENGINEERING, INC. WE	GEOTECHNICAL ENGINEERING ▫ CONSTRUCTION SERVICES ENVIRONMENTAL SERVICES AND ENGINEERING 3772 PLEASANTDALE ROAD - SUITE 165 ATLANTA, GA 30340-4270
DATE: 6/14/2012		
DRAWN BY: CDL		
REVIEWED BY: SKB		

FIGURE 4

GENERALIZED SUBSURFACE PROFILE B-B'
LIDDELL DRIVE EQUALIZATION PROJECT
ATLANTA, FULTON COUNTY, GEORGIA
WILLMER PROJECT No. 71.3801

P:\3801 Peachtree Creek Alternative LD-1\CADD\GENERALIZED SUBSURFACE PROFILES.dwg



NOTES

1. GROUND SURFACE ELEVATIONS AT THE BORING LOCATIONS WERE PROVIDED TO WILLMER BY ATLANTA SERVICES GROUP. THE APPROXIMATE EXISTING GROUND SURFACE WAS ESTIMATED BY INTERPOLATION USING A TOPOGRAPHIC MAP PROVIDED BY ASG.
2. THE SOIL STRATIGRAPHY SHOWN ON THIS PROFILE REPRESENTS OUR INTERPRETATION OF THE BORING DATA IN ACCORDANCE WITH GENERALLY ACCEPTED GEOTECHNICAL ENGINEERING PRACTICE. THE LINES SHOWING STRATA BREAKS ARE APPROXIMATE AND BASED ON LINEAR INTERPOLATION BETWEEN BORINGS. THE ACTUAL TRANSITION BETWEEN SOIL STRATA ARE EXPECTED TO BE GRADUAL, AND THE DEPTH/ELEVATION OF ANY STRATUM BETWEEN TWO BORINGS COULD BE DIFFERENT FROM WHAT IS SHOWN ON THIS PROFILE.

SCALE: 1" = 200' H' 1" = 20' V'	WILLMER ENGINEERING INC. WE	GEOTECHNICAL ENGINEERING ▫ CONSTRUCTION SERVICES ENVIRONMENTAL SERVICES AND ENGINEERING 3772 PLEASANTDALE ROAD - SUITE 165 ATLANTA, GA 30340-4270
DATE: 6/14/2012		
DRAWN BY: CDL		
REVIEWED BY: SKB		

FIGURE 5

GENERALIZED SUBSURFACE PROFILE C-C'
LIDDELL DRIVE EQUALIZATION PROJECT
ATLANTA, FULTON COUNTY, GEORGIA
WILLMER PROJECT No. 71.3801

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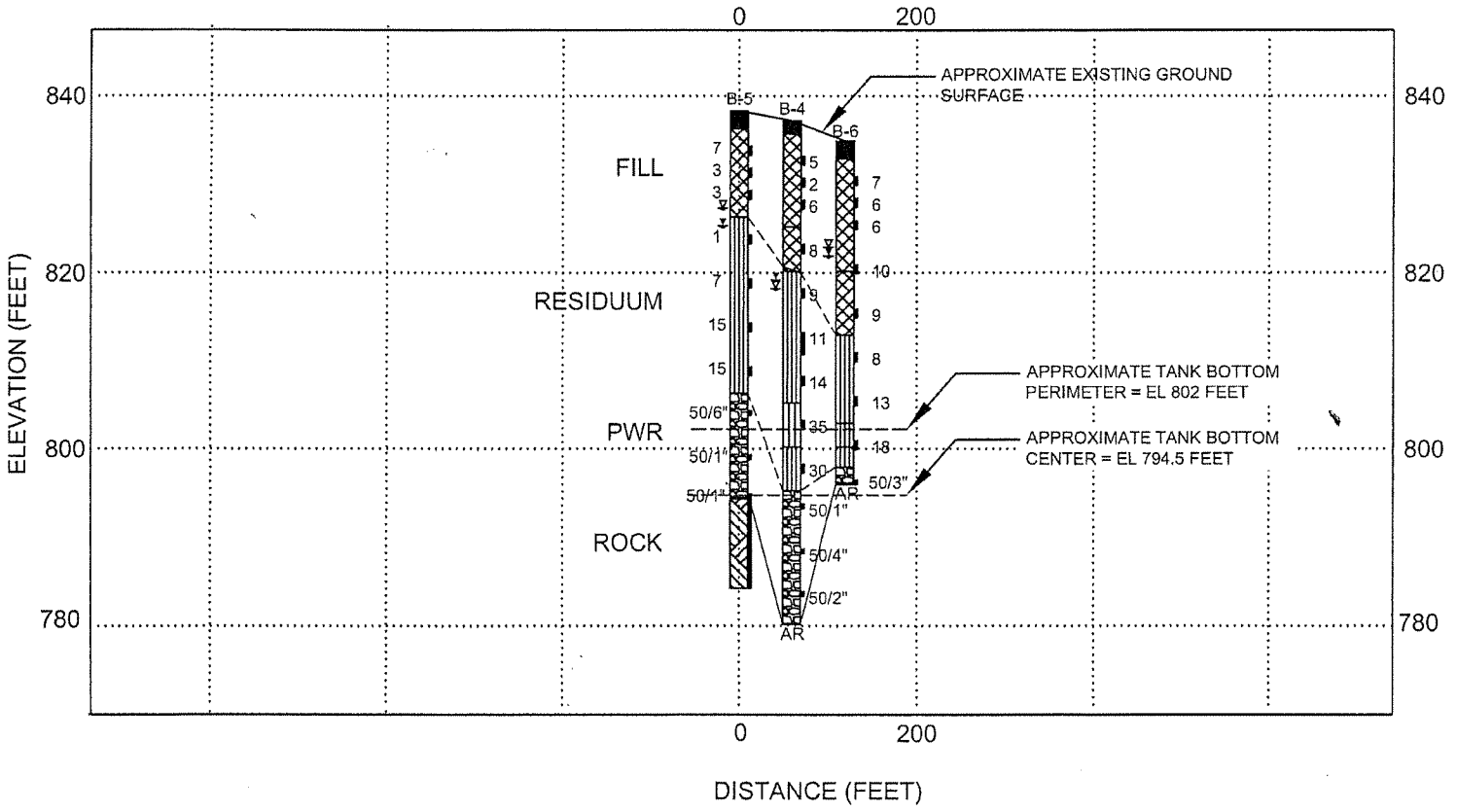

NOTES

1. GROUND SURFACE ELEVATIONS AT THE BORING LOCATIONS WERE PROVIDED TO WILLMER BY ATLANTA SERVICES GROUP. THE APPROXIMATE EXISTING GROUND SURFACE WAS ESTIMATED BY INTERPOLATION USING A TOPOGRAPHIC MAP PROVIDED BY ASG.

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SCALE: 1" = 200' H' 1" = 20' V'	WILLMER ENGINEERING, INC.	GEOTECHNICAL ENGINEERING ▫ CONSTRUCTION SERVICES ENVIRONMENTAL SERVICES AND ENGINEERING 3772 PLEASANTDALE ROAD - SUITE 165 ATLANTA, GA 30340-4270	FIGURE 6 GENERALIZED SUBSURFACE PROFILE D-D' LIDDELL DRIVE EQUALIZATION PROJECT ATLANTA, FULTON COUNTY, GEORGIA WILLMER PROJECT No. 71.3801
DATE: 6/14/2012			
DRAWN BY: DCP			
REVIEWED BY:SKB			

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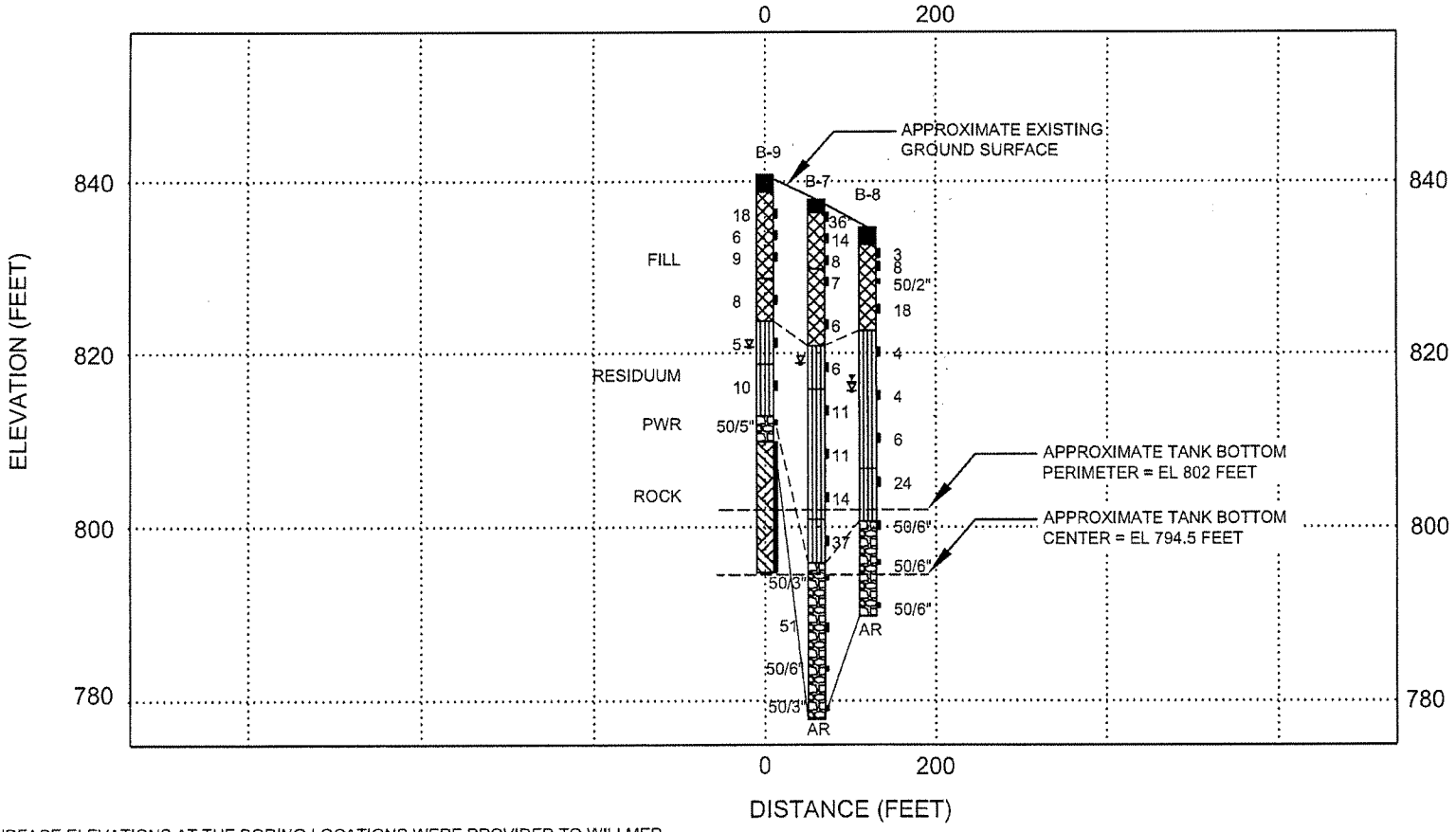

NOTES

1. GROUND SURFACE ELEVATIONS AT THE BORING LOCATIONS WERE PROVIDED TO WILLMER BY ATLANTA SERVICES GROUP. THE APPROXIMATE EXISTING GROUND SURFACE WAS ESTIMATED BY INTERPOLATION USING A TOPOGRAPHIC MAP PROVIDED BY ASG.

2. THE SOIL STRATIGRAPHY SHOWN ON THIS PROFILE REPRESENTS OUR INTERPRETATION OF THE BORING DATA IN ACCORDANCE WITH GENERALLY ACCEPTED GEOTECHNICAL ENGINEERING PRACTICE. THE LINES SHOWING STRATA BREAKS ARE APPROXIMATE AND BASED ON LINEAR INTERPOLATION BETWEEN BORINGS. THE ACTUAL TRANSITION BETWEEN SOIL STRATA ARE EXPECTED TO BE GRADUAL, AND THE DEPTH/ELEVATION OF ANY STRATUM BETWEEN TWO BORINGS COULD BE DIFFERENT FROM WHAT IS SHOWN ON THIS PROFILE.

SCALE: 1" = 200' H' 1" = 20' V'	WILLMER ENGINEERING INC. WE	GEOTECHNICAL ENGINEERING ▪ CONSTRUCTION SERVICES ENVIRONMENTAL SERVICES AND ENGINEERING 3772 PLEASANTDALE ROAD - SUITE 165 ATLANTA, GA 30340-4270
DATE: 6/14/2012		
DRAWN BY: CDL		
REVIEWED BY: SKB		

FIGURE 7

GENERALIZED SUBSURFACE PROFILE E-E"
LIDDELL DRIVE EQUALIZATION PROJECT
ATLANTA, FULTON COUNTY, GEORGIA
WILLMER PROJECT No. 71.3801

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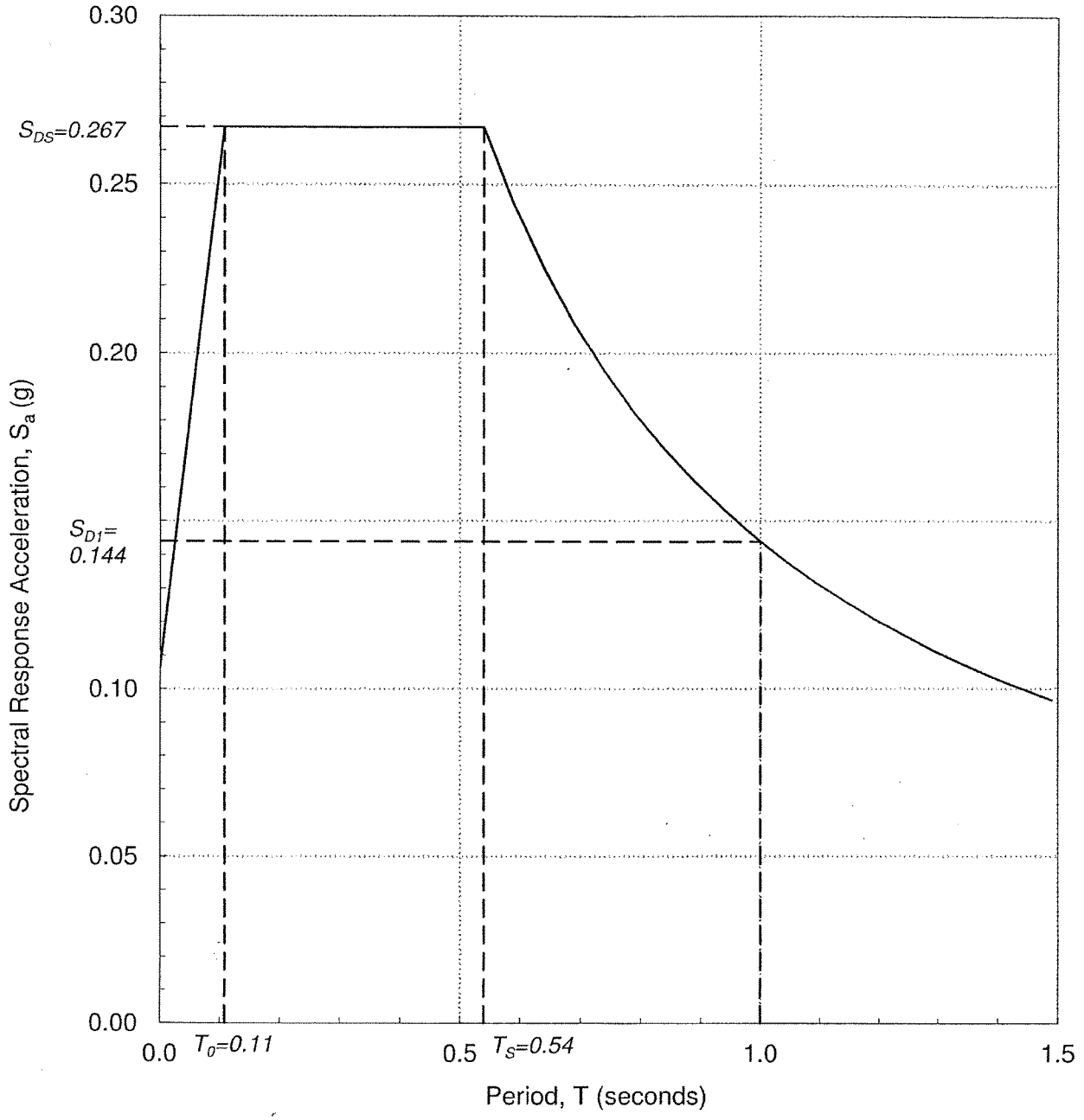


Design Response Spectrum - Site Class 'D'

SCALE: N.T.S.			FIGURE 8
DATE: 6/14/2012	WE	GEOTECHNICAL ENGINEERING CONSTRUCTION SERVICES ENVIRONMENTAL SERVICES AND ENGINEERING 3772 PLEASANTDALE ROAD - SUITE 165 ATLANTA, GA 30340-4270	DESIGN RESPONSE SPECTRUM LIDDELL DRIVE EQUALIZATION PROJECT ATLANTA, FULTON COUNTY, GEORGIA WILLMER PROJECT No. 71.3801
DRAWN BY: DCP			
REVIEWED BY: SKB			

P:\3801 Peachtree Creek Alternative LD-1\CADD\FIGURE 8 DESIGN RESPONSE.dwg

APPENDIX I

WILLMER ENGINEERING INC. WE

BORING RECORD LEGEND

SM, CL, etc: - GROUP SYMBOL based on Unified Soil Classification System.
(Refer to ASTM D-2488 and Table 1 of D-2487)

N-VALUE: BLOWS PER FOOT- Standard Penetration Resistance (SPT) blow count , the sum of the second and third 6-inch increments of the SPT test.
(Refer to ASTM D-1586)

CONSISTENCY / RELATIVE DENSITY Correlated with SPT Blow Count, N:

SILTS AND CLAYS

N (blows per foot)	Consistency
0 - 2	Very Soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
16 - 30	Very Stiff
31 - 50	Hard
> 50	Very Hard

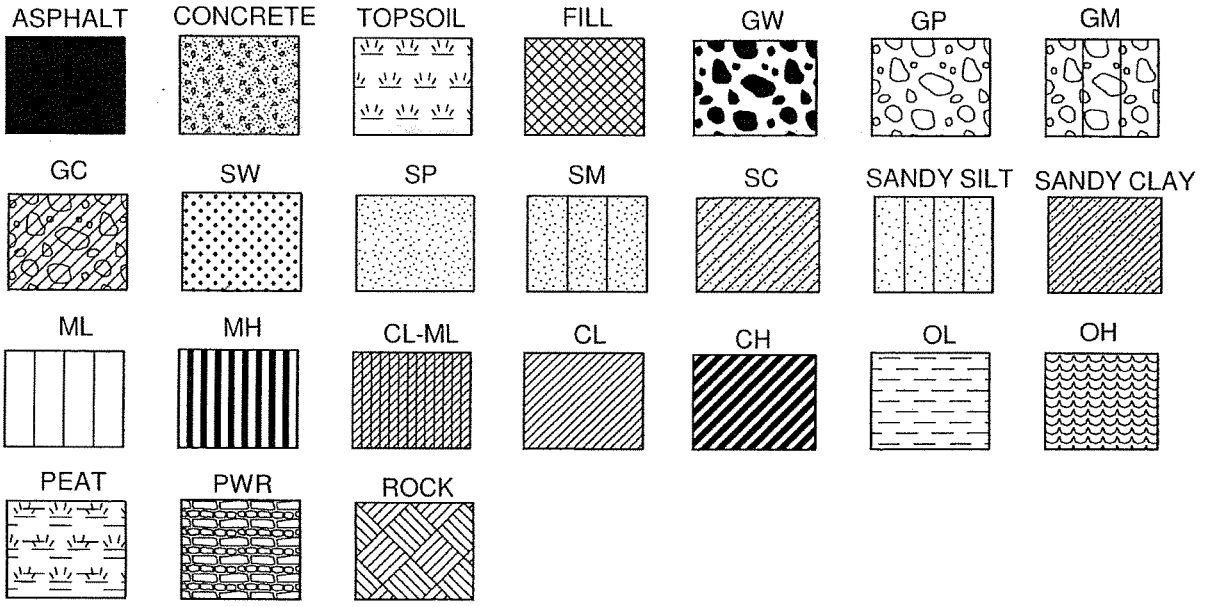
SANDS

N (blows per foot)	Relative Density
0 - 4	Very Loose
5 - 10	Loose
11 - 30	Medium Dense
31 - 50	Dense
> 50	Very Dense

NOTES:

Groundwater Measurements:

- Water level at time of backfilling
- Water level at time of boring
- Caved level at 24 hours



WILLMER ENGINEERING INC. WE

Willmer Engineering Inc.
3772 Pleasantdale Road, Suite 165
Atlanta, Georgia 30340

UNIFIED SOIL CLASSIFICATION SYSTEM REFERENCE SHEET

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN #200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED #4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	(GW)	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
			(GP)	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES APPRECIABLE AMOUNT OF FINES	(GM)	SILTY GRAVELS and GRAVEL-SAND-SILT MIXTURES
			(GC)	CLAYEY GRAVELS and GRAVEL-SAND-CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING #4 SIEVE	CLEAN SAND LITTLE OR NO FINES	(SW)	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
			(SP)	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		SANDS WITH FINES APPRECIABLE AMOUNT OF FINES	(SM)	SILTY SANDS and SAND-SILT MIXTURES
			(SC)	CLAYEY SANDS and SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN #200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		(ML)	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR VERY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			(CL)	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			(OL)	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		(MH)	INORGANIC ELASTIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS
			(CH)	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			(OH)	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			(PT)	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

WILLMAR ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-1
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **844.90** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **8** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **34.0**

Logged By: **DP** Date Drilled: **2/16/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Pavement System = 24 inches		844.9		
5		SS			FILL: Firm black, orange, and greenish orange medium to fine sandy **SILT** with traces of black debris, trash, and coal-like material (possible dump site)	FILL	840		8
		SS							5
10		SS					835		5
15		SS			RESIDUUM: Firm to stiff reddish grey and brown medium to fine sandy **SILT** with strong smell of gasoline, micacous	ML	830		7
20		SS			Stiff greyish green, orange and white medium to fine sandy **SILT** with smell of gasoline, micacous	ML	825		14
25		SS					820		13
30		SS			Hard orange and white sandy **SILT**, micacous	ML	815		33
		SS			PARTIALLY WEATHERED ROCK: Sampled as very hard reddish orange sitly medium to fine **SAND**	PWR			50/5"

Auger refusal was encountered at 34 feet below the existing ground surface.

Groundwater was encountered at 19 feet and 18.5 feet below the existing ground surface at the time of boring completion and after 24 hours respectively.

A piezometer was installed to a depth of 25 feet below the existing ground suface.

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-1**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-2
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **843.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **7** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **31.0**

Logged By: **DP** Date Drilled: **2/16/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	MATERIAL DESCRIPTION		ELEVATION (feet)
		Pavement System = 18 inches		843.0
5	SS	FILL: Medium dense to very loose black silty medium to fine **SAND** with debris and trash such as glass, metal, and coal-like material (possible dump site)	FILL	840
	SS			
10	SS			835
15	SS	RESIDUUM: Very stiff reddish orange, tan, and black medium to fine sandy **SILT**, micaceous with layers of white coarse to fine sand	ML	830
20	SS	Very stiff green, orange, and white medium to fine sandy **SILT** with gas smell	ML	825
25	SS	Dense tan and orange silty medium to fine **SAND**	SM	820
30	SS	PARTIALLY WEATHERED ROCK: Sampled as very dense tan, orange and brown silty coarse to fine **SAND** with rock fragments	PWR	815
		Auger refusal was encountered at 31 feet below the existing ground surface at the time of boring completion.		
		Groundwater was encountered at 20.5 and 20 feet below the existing ground surface at the time of boring completion and after 24 hours respectively.		
		A piezometer was installed to a depth of 27 feet below the existing ground surface to monitor groundwater level.		

STANDARD PENETRATION TEST DATA (blows/foot)

N-VALUE
12
3
4
22
25
47
50/1"

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-2**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-3
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **845.60** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **7** Overburden (ft): **28** Rock (ft): **13** Total Depth (ft): **41.0**

Logged By: **DP** Date Drilled: **2/20/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)
					Pavement System = 18 Inches	845.6
5		SS			FILL: Loose black silty medium to fine **SAND** with decomposing organics, debris and trash such as glass, wood, and metal (possible dump site) **FILL**	845
		SS				
10		SS			Very soft medium to fine sandy **CLAY** with wood and glass debris **FILL**	840
15		SS			RESIDUUM: Stiff grey and orange medium to fine sandy **CLAY** **SC**	835
20		SS			Stiff to very stiff orange and black medium to fine sandy **SILT**, micacous **ML**	830
		ST				825
25		SS				820
		SS				
30		NQ	62	15	ROCK: Hard to very hard biotite gniess	815
35		NQ	55	32		810
40		NQ	64	35		805
					Auger refusal was encountered at 28 feet below the existing ground surface at the time of boring completion.	
					Groundwater was encountered at 14 feet and 9 feet below the existing ground surface at the time of boring completion and after 24 hours respectively.	
					A Shelby tube sample was taken from depths 20 to 21.5 feet.	

STANDARD PENETRATION TEST DATA (blows/foot)

N-VALUE	
7	
5	
2	
9	
12	
25	
50/0"	

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-3**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-4
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **837.20** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **13** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **58.0**

Logged By: **DP** Date Drilled: **2/20/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
0					Pavement System = 18 inches	837.2	
5		SS			FILL: Loose to very loose black silty **SAND** with decomposing organics, debris and trash such as wood, glass, and metals (possible dump site) **FILL**	835	5
		SS				830	2
10		SS					6
					Firm tan and grey medium to fine sandy **CLAY** with organic debris **FILL**	825	
15		SS					8
					RESIDUUM: Stiff and firm orange, tan, and red medium to fine sandy **SILT**, very micacous **ML**	820	
20		SS					9
						815	
25		SS					11
		ST				810	
30		SS					14
					Dense red and orange medium to fine **SAND** with rock fragments **SM**	805	
35		SS					35
					Very stiff red and orange medum to fine sandy **SILT** **ML**	800	
40		SS					30
					PARTIALLY WEATHERD ROCK: Sampled as very hard red, orange, and brown fine sandy **SILT** with layers of white silty coarse to fine SAND **PWR**	795	
45		SS					50/1"
						790	
50		SS					50/4"
						785	
55		SS					50/2"

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

Continued Next Page

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-4**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-4
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
						780		

Auger refusal was encountered at 57 feet below the existing ground surface.

Groundwater was encountered at 19 feet and 18 feet below the existing ground surface at the time of boring completion and after 24 hours respectivly.

A Shelby tube sample was taken from a depths 25 to 26.5 feet below the existing ground surface.

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-4**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING, INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-5
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **838.30** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **10** Overburden (ft): **44** Rock (ft): **10** Total Depth (ft): **54.0**

Logged By: **DP** Date Drilled: **2/16/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot)	N-VALUE
					Pavement System = 24 inches	838.3		
5		SS			FILL: Loose to very loose black silty **SAND** with decomposing organics, debris and trash (possible dump site) **FILL**	835		7
		SS						3
10		SS				830		3
15		SS			RESIDUUM: Very soft to stiff orange, tan, and red medium to fine sandy **SILT**, micacous **ML**	825		1
20		SS				820		7
25		SS				815		15
30		SS				810		15
35		SS			PARTIALLY WEATHERD ROCK: Sampled as very hard reddish brown, orange, and black fine sandy **CLAY** with rock fragments, layer of tan and white silty coarse to fine SAND **PWR**	805		50/6"
40		SS				800		50/1"
45		SS				795		50/1"
		NQ	50	14	ROCK: Hard to very hard biotite gniess	790		
50		NQ	91	66		785		

Continued Next Page

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-5**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-5
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Auger refusal was encountered at 44 feet below the existing ground surface at the time of boring completion. Groundwater was encountered at 13 feet and 11 feet below the existing ground surface at the time of boring completion and after 24 hours respectively.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-5**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-6
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **834.90** Station: **N/A**
Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**
Core Boxes: **N/A** Samples: **9** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **39.0**
Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N-VALUE
				Pavement System = 24 inches		834.9	
5	SS			FILL: Loose black silty **SAND** with decomposing organics, debris and trash, such as wood and glass (possible dump site)	FILL	830	7
	SS						6
10	SS					825	6
15	SS					820	10
20	SS			Stiff tan and grey medium to fine sandy **CLAY**	FILL	815	9
25	SS			RESIDUUM: Stiff and firm orange, tan, and red medium to fine sandy **SILT**, micacous	ML	810	8
30	SS					805	13
35	SS			Very stiff tan and orange coarse to fine sandy **SILT**	ML	800	18
	SS			PARTIALLY WEATHERD ROCK: Sampled as very hard red, orange, and brown fine sandy **SILT** with layer of white silty coarse to fine SAND	PWR		50/3"
				Auger refusal was encountered at 39 feet below the existing ground surface.			
				Groundwater was encountered at 12 feet and 13 feet below the existing ground surface at the time of boring completion and after 24 hours respectively.			

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-6**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WELLMAN ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-7
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **837.90** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **14** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **60.0**

Logged By: **DP** Date Drilled: **2/21/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot)	N-VALUE
					Pavement System = 18 inches		837.9		
0		SS			FILL: Dense to loose black silty **SAND** with debris and trash such as glass, crushed concrete and coal-like material (possible dump site) *Initial SS amplified by debris	FILL	835		36*
5		SS							14
		SS							8
		SS			Loose black and orange clayey medium to fine **SAND** with decomposing organics, debris, trash, and rocks	FILL	830		7
10		SS							
		SS					825		6
15									
		SS			RESIDUUM: Firm orange and tan medium to fine sandy clayey **SILT**	ML	820		6
20									
		SS			Stiff orange, tan, and red medium to fine sandy **SILT**, very micacous	ML	815		11
25									
		SS					810		11
30									
		SS					805		14
35									
		SS			Hard tan and orange medium to fine sandy **SILT**, very micacous	ML	800		37
40									
		SS			PARTIALLY WEATHERD ROCK: Sampled as very hard red, orange, and brown medium to fine sandy **SILT**, very micacous, with layer of white silty coarse to fine SAND	PWR	795		50/3"
45		SS							
							790		51
50		SS							
		SS					785		50/6"
55									

Continued Next Page

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-7**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-7
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
		SS				780		50/3"
60					Boring was terminated at a depth of 60 feet below the existing ground surface. Groundwater was encountered at 19 feet below the existing ground surface at the time of boring completion.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-7**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WITTMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-8
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **834.70** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **11** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **45.0**

Logged By: **DP** Date Drilled: **2/16/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Pavement System = 24 inches	834.7		
5		SS			FILL: Very loose to medium dense black silty medium to fine **SAND** with debris and trash such as wood, glass, and coal-like material (high blows at 6.5 feet due to hammer bounce on trash and debris) **FILL**	830		3
		SS						8
		SS						50/2"
10		SS				825		18
15		SS			RESIDUUM: Soft to firm gold, black, and tan medium to fine sandy **SILT**, very micacous **ML**	820		4
20		SS				815		4
25		SS				810		6
30		SS			Very stiff tan, brown and orange medium to fine sandy **SILT**, very micacous **ML**	805		24
35		SS			PARTIALLY WEATHERED ROCK : Sampled as very hard tan, brown, and white coarse to fine sandy **SILT**, very micacous **PWR**	800		50/6"
40		SS				795		50/6"
45		SS				790		50/6"
					Auger refusal was encountered at 45 feet below the existing ground surface.			
					Groundwater was encountered at 19 feet and 18 feet below the existing ground surface at the time of boring completion and after 24 hours respectivly.			

Continued Next Page

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-8**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-8
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					A piezometer was installed to a depth of 25 feet below the existing ground surface.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-8**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-9
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **840.80** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **7** Overburden (ft): **31** Rock (ft): **15** Total Depth (ft): **46.0**

Logged By: **DP** Date Drilled: **2/16/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)
					Pavement System = 24 inches	840.8
5		SS			FILL: Medium dense to loose black silty coarse to fine **SAND** with trace organics, debris, and trash, such as wood, metals, glass, and milled asphalt (possible dump site) **FILL**	840
		SS				835
10		SS				830
15		SS			Firm black and tan clayey medium to fine **SAND** **FILL**	825
20		SS			Firm reddish brown medium to fine sandy **CLAY** **ML**	820
25		SS			RESIDUUM: Loose reddish orange silty medium to fine **SAND**, very micacous **ML**	815
30		SS			PARTIALLY WEATHERD ROCK: Sampled as very hard reddish orange medium to fine sandy **SILT** **PWR**	810
35		NQ	23	8	ROCK: Moderatly hard to hard mica schist and biotite gneiss	805
40		NQ	46	26		800
45		NQ	43	18		795
					Auger refusal was encountered at 31 feet below the existing ground surface.	
					Groundwater was encountered at 20 feet below the existing ground surface at the time of boring completion.	

STANDARD PENETRATION TEST DATA (blows/foot)

N-VALUE
18
6
9
8
5
10
50/5"

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-9**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-10
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **845.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **5** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **20.0**

Logged By: **DP** Date Drilled: **2/20/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Pavement System = 18 inches	845.0		
5		SS			RESIDUUM: Dense to very dense reddish brown silty medium to fine **SAND**, micaceous **SM**	840		31
		SS						40
10		SS				835		71
15		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense greenish grey silty medium to fine **SAND**, slightly micaceous **PWR**	830		50/6"
20		SS				825		50/4"
					Boring was terminated at 20 feet below the existing ground surface.			
					No groundwater was encountered at the time of boring completion.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-10**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-11
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **832.50** Station: **N/A**
Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**
Core Boxes: **N/A** Samples: **10** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **40.0**
Logged By: **DP** Date Drilled: **2/16/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
0	SS			FILL: Medium dense reddish orange and brown silty medium to fine **SAND** with trace organics and debris such as glass, and milled asphalt (possible dump site) — FILL	832.5	18
5	SS			Loose black and brown sitly **SAND** with organics and debris — FILL	830	9
	SS				825	10
10	SS			Firm grey medium to fine sandy **CLAY** — FILL		6
15	SS			RESIDUUM: Loose greenish grey silty medium to fine **SAND**, slightly micacous — SM	820	6
20	SS			Loose to medium dense orange, tan, and red silty medium to fine **SAND** — SM	815	6
25	SS				810	13
30	SS			Hard red, black, and tan medium to fine sandy **SILT**, micacous — ML	805	18
					800	60
35	SS			PARTIALLY WEATHERED ROCK: Sampled as very hard red, black, and tan silty coarse to fine **SAND**, slightly micacous with rock fragments — PWR	795	50/5"
40	SS					50/6"

Auger refusal was encountered at 40 feet below the existing ground surface.

Groundwater was encountered at 13 feet and 11.5 feet below the existing ground surface at the time of boring completing and after 24 hours respectively.

A piezometer was installed to a depth of 25 feet below the existing ground surface.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-11**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-13A
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **860.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **5** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **13.5**

Logged By: **DP** Date Drilled: **2/23/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Pavement System = 8 inches	860.0		
		SS			FILL: Tannish orange, brown, and grey silty medium to fine **SAND** with small to large rock fragments (possible boulder fill)			20
5		SS				855		50/5"
		SS						10
10		SS				850		5
		SS						50/0"
					Auger refusal was encountered at 14 feet below the existing ground surface. Auger refusal was also encountered at offset locations at depths of 4.5, 7.5, 4, and 8 feet below the existing ground surface.			
					No groundwater was encountered at the time of boring completion			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-13A**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-13B
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **861.50** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **11** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **42.0**

Logged By: **DP** Date Drilled: **2/23/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
0		SS			Pavement System = 6 inches / FILL: Dense grey and white silty medium to fine **SAND** with rock fragments	861.5	
5		SS			dense to loose black and brown silty medium to fine **SAND** with debris and organics	860	32
		SS					34
		SS				855	5
10		SS					14
					medium dense to loose grey, brown, and orange clayey medium to fine **SAND** — FILL	850	
15		SS					11
						845	
20		SS					7
					Medium dense greenish tan and brown clayey coarse to fine **SAND**, trace organics such as plant fibers — FILL	840	
25		SS					13
					RESIDUUM: Stiff orange and brown medium to fine sandy **SILT**, micacous — ML	835	
30		SS					13
						830	
35		SS					14
						825	
40		SS			Hard orange and brown medium to fine sandy **SILT**, micaceous — ML		46
		SS				820	50/1"

Auger refusal was encountered at 42 feet below the existing ground surface.

Auger refusal was encountered at adjacent offsets at a depth of 12 feet below the existing ground surface.

No groundwater was observed at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-13B**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**	**HOLE No. B-14**
Location: **Fulton County, Georgia**	Sheet 1 of 1
Project Number: **71.3801**	Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **839.50** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **6** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **22.0**

Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
		SS			Topsoil = 4 inches / FILL	839.5	
		SS			FILL: Stiff red medium to fine sandy **CLAY**		11
5		SS				835	13
		SS			RESIDUUM: Stiff reddish orange medium to fine sandy **SILT**, micaceous / ML		13
10		SS				830	13
		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense tan and grey silty medium to fine **SAND** / PWR	825	50/5"
15							
20		SS				820	50/6"

Auger refusal was encountered at 22 feet below the existing ground surface.

No groundwater was observed at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)

5 10 20 40 60 80

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-14**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-15A
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **818.10** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **7** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **24.0**

Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
	SS			Topsoil = 4 inches — FILL	818.1	
	SS			FILL: Soft to stiff brown fine sandy **SILT**, micaceous	815	4
5	SS					6
	SS				810	11
	SS			ALLUVIUM: Soft to firm tan and grey fine sandy **SILT**, slightly micacous — ML		8
10	SS				805	
	SS			RESIDUUM: Very dense greenish tan silty medium to fine **SAND** — SM		65
15	SS				800	
	SS					35
20	SS			PARTIALLY WEATHERED ROCK: Sampled as Very dense tan, orange, and white silty coarse to fine **SAND** with rock fragments — PWR	795	50/4"

The boring encountered auger refusal at 24 feet below the existing ground surface.

Groundwater was encountered at 8 feet below the existing ground surface at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-15A**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WELLMER ENGINEERING, INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-16
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **812.00** Station: **N/A**
Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**
Core Boxes: **N/A** Samples: **8** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **29.0**
Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot)	N-VALUE
		SS			Topsoil = 2 inches SC	812.0		
		SS			ALLUVIUM: Very soft to soft greyish brown medium to fine sandy **CLAY** SC	810		2
5		SS			Very loose tan and grey clayey medium to fine **SAND**, slightly micacous SM	805		3, 4
		SS			Loose tan and grey silty medium to fine **SAND**, slightly micacous SM			5
10		SS			Loose to medium dense orange and tan silty medium to fine **SAND**	800		
15		SS				795		20
20		SS			PARTIALLY WEATHERED ROCK: PWR Sampled as Very dense tan, orange, and white silty coarse to fine **SAND** with rock fragments	790		50/6"
25		SS				785		50/4"
		SS						50/5"
					The boring was terminated at a depth of 30 feet below the existing ground surface.			
					Groundwater was encountered at 3 feet below the existing ground surface at the time of boring completion.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-16**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMS ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-17
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **813.70** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **8** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **30.0**

Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
0	SS			Topsoil = 4 inches — FILL	813.7	3
				FILL: Very loose reddish brown silty medium to fine **SAND** — CL		
5	SS			ALLUVIUM: Soft to very soft grey fine sandy **CLAY**	810	3
	SS					3
10	SS				805	2
				Medium dense grey and white silty coarse to fine **SAND** — SM	800	27
15	SS					
				PARTIALLY WEATHERED ROCK: Sampled as very dense grey, tan, and orange silty coarse to fine **SAND** slightly micacaous — PWR	795	50/5"
20	SS					
					790	50/3"
25	SS					
					785	50/3"
30	SS			The boring was terminated at 29 feet below the existing ground surface.		
				Groundwater was encountered at 6 feet below the existing ground surface at the time of boring completion.		

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-17**

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**	**HOLE No. B-18**
Location: **Fulton County, Georgia**	Sheet 1 of 1
Project Number: **71.3801**	Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **813.50** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **8** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **28.5**

Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
0	SS			Topsoil = 1 inches / FILL	813.5	3
				FILL: Very loose reddish brown silty medium to fine **SAND** / SC		
5	SS			ALLUVIUM: Looe to very loose grey clayey medium to fine **SAND**	810	5
	SS					4
10	SS				805	3
				RESIDUUM: Medium dense geenish grey and white silty coarse to fine **SAND** / SM		
15	SS			PARTIALLY WEATHERED ROCK: Sampled as very dense grey, tan, and orange silty coarse to fine **SAND**, slightly micacaous / PWR	800	28
20	SS				795	50/5"
25	SS				790	50/3"
	SS			The boring was terminated at 28.5 feet below the existing ground surface.	785	50/1"
				Groundwater was encountered at 7 feet below the existing ground surface at the time of boring completion.		

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-18**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-19
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: **--** Angle from Horizontal: **90** Surface Elevation (ft): **813.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **6** Overburden (ft): **20** Rock (ft): **10** Total Depth (ft): **30.0**

Logged By: **DP** Date Drilled: **2/21/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N-VALUE
0	SS			ALLUVIUM: Very loose to loose brown silty medium to fine **SAND**	SM	813.0	2
5	SS					810	9
	SS			Loose to very loose grey and tan coarse to fine **SAND** with pebbles	SM		4
10	SS					805	6
	SS			RESIDUUM: Dense grey and white silty medium to fine **SAND**	SM	800	46
15	SS						
	SS			PARTIALLY WEATHERED ROCK: Sampled as very dense brownish orange silty coarse to fine **SAND**	PWR	795	50/5"
20	NQ	26	0	ROCK: Moderately hard to hard biotite gneiss and mica schist		790	
25	NQ	55	0			785	
30				Auger refusal was encountered at 20 feet below the existing ground surface.			
				Groundwater was encountered at 5 feet below the existing ground surface at the time of boring completion.			

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-19**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

Wellmer Engineering Inc. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-20
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: **--** Angle from Horizontal: **90** Surface Elevation (ft): **813.50** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **5** Overburden (ft): **17** Rock (ft): **10** Total Depth (ft): **27.0**

Logged By: **DP** Date Drilled: **2/21/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)
0		SS			Topsoil = 3 inches (ML)	813.5
		SS			ALLUVIUM: Soft reddish brown medium to fine sandy **SILT**, micacous	
5		SS			Loose reddish brown and tan silty medium to fine **SAND** (SM)	810
		SS				
10		SS			Loose tan and brown silty coarse to fine **SAND** (SM)	805
		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense brown and grey silty medium to fine **SAND** (PWR)	800
15		NQ	15	13	ROCK: Moderatly hard to hard mica schist and biotite gneiss (mostly PWR)	795
20		NQ	5	0		790
25						

Auger refusal was encountered at 17 feet below the existing ground surface.

Groundwater was encountered at 6 feet below the existing ground surface at the time of boring completion.

A 10-foot NQ rock core sample was retrieved from 17 feet to 27 feet

STANDARD PENETRATION TEST DATA (blows/foot)

5	10	20	40	60	80	N-VALUE
						4
						4
						4
						6
						6
						50/1"

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-20**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-21
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **812.40** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **8** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **29.0**

Logged By: **DP** Date Drilled: **2/21/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N-VALUE
0	SS			Topsoil = 2 inches	SM	812.4	2
	SS			ALLUVIUM: Very loose to loose reddish orange silty medium to fine **SAND**, micacous		810	6
5	SS						2
	SS			Very loose greyish brown clayey medium to fine **SAND**	SC	805	2
10	SS						
	SS			Medium dense grey and white silty coarse to fine **SAND**	SM	800	13
15	SS			RESIDUUM: Medium dense to very dense brown, green and white silty medium to fine **SAND**, micacous	SM	795	23
20	SS			Very dense orange and brown silty medium to fine **SAND**	SM	790	55
25	SS			PARTIALLY WEATHERED ROCK: Sampled as very dense brown, white, and orange silty medium to fine **SAND**	PWR	785	50/4"

Boring was terminated at 29 feet below the existing ground surface.

Groundwater was encountered at 6.5 feet below the existing ground surface at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-21**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. | WE

Project: **Liddell Drive Equalization Project** Location: **Fulton County, Georgia** Project Number: **71.3801**	**HOLE No. B-22** Sheet 1 of 1 Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **811.50** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **5** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **17.5**

Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
		SS			Topsoil = 3 inches / FILL: Soft medium to fine sandy **SILT**, slightly micaceous	811.5	4
5		SS			ALLUVIUM: Very loose grey silty coarse to fine **SAND** (SM)	810	2
		SS				805	3
10		SS					4
						800	
15		SS			RESIDUUM: Dense grey, black, and white silty coarse to fine **SAND** with rock fragments (SM)	795	33

Auger refusal was encountered at 17.5 feet below the existing ground surface.

Groundwater was encountered at 6 feet below the existing ground surface at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)

5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-22**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-23
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **811.60** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **6** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **19.0**

Logged By: **DP** Date Drilled: **2/15/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)
0	SS			Topsoil = 2 inches — CL	811.6
	SS			ALLUVIUM: Soft reddish brown and grey medium to fine sandy **CLAY**, slightly micaceous	810
5	SS				805
	SS			Very loose grey clayey medium to fine **SAND** — SC	
10	SS				800
15	SS			PARTIALLY WEATHERED ROCK: Sampled as very dense grey, black, and tan silty coarse to fine **SAND** — PWR	795
	SS				

Boring was terminated at 20 feet below the existing ground surface.

Groundwater was encountered at 5 feet below the existing ground surface at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)

5	10	20	40	60	80	N-VALUE
						3
						4
						2
						4
						50/5"
						50/5"

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-23**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILMER ENGINEERING, INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-24
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **861.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **12** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **49.5**

Logged By: **DP** Date Drilled: **2/23/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
				Pavement System = 11 inches	861.0	
	SS			FILL: Dense black brown silty medium to fine **SAND** with large rock fragments — FILL	860	33
	SS			Medium dense to loose brown and orange silty coarse to fine **SAND** with rock fragments		13
5	SS				855	8
				RESIDUUM: Medium dense reddish brown silty medium to fine **SAND**, micacous — SM		18
10	SS				850	
15	SS				845	14
				PARTIALLY WEATHERED ROCK: Sampled as very dense tan and white silty coarse to fine **SAND**, slightly micacous — PWR		
20	SS				840	50/5"
25	SS				835	50/6"
30	SS				830	50/4"
35	SS					50/5"
40	SS				825	50/5"
				▽	820	
45	SS				815	50/4"
	SS					50/4"
				Auger refusal was encountered at 49.5 feet below the existing ground surface.		

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

Continued Next Page

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-24**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WELLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-24
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Groundwater was encountered at 42 feet below the existing ground surface at the time of boring completion.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-24**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**	**HOLE No. B-25**
Location: **Fulton County, Georgia**	Sheet 1 of 1
Project Number: **71.3801**	Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **812.90** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **6** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **20.0**

Logged By: **DP** Date Drilled: **2/22/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
		SS			Topsoil = 3 inches / FILL: Firm reddish brown medium to fine sandy **SILT**, slightly micaceous	812.9	6
5		SS				810	6
		SS			ALLUVIUM: Very loose to loose grey clayey medium to fine **SAND** SC		5
10		SS				805	4
		SS				800	10
15						795	
20		SS			PARTIALIY WEATHERED ROCK: Sampled as very dense tan and brown medium to fine sandy **SILT** micacous PWR		50/5"

Boring was terminated at 20 feet below the existing ground surface.

Groundwater was encountered at 8 feet below the existing ground surface at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)

5 10 20 40 60 80

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-25**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-26
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: **--** Angle from Horizontal: **90** Surface Elevation (ft): **811.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **7** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **24.0**

Logged By: **DP** Date Drilled: **3/1/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
0		SS			Topsoil = 2 inches / FILL: Firm to soft reddish brown medium to fine sandy **CLAY** slightly micaceous	811.0	5
5		SS				810	3
		SS			ALLUVIUM: Very loose to loose grey and white clayey coarse to fine **SAND** (SC)	805	3
10		SS					7
		SS			RESIDUUM: Very dense greyish blue silty medium to fine **SAND** (SM)	800	55
15		SS				795	
20		SS			PARTIALY WEATHERED ROCK: Sampled as very dense greyish blue silty medium to fine **SAND** (PWR)	790	50/3"
		SS			Boring was terminated at 24 feet below the existing ground surface.		50/3"

Groundwater was encountered at 5 feet below the existing ground surface at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-26**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-27
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **817.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **8** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **29.0**

Logged By: **DP** Date Drilled: **3/1/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
		SS			Gravel Road = 3 inches / FILL: Medium dense brown clayey medium to fine **SAND** (FILL)	817.0	13
		SS			(ML) RESIDUUM: Stiff to firm reddish brown medium to fine sandy **SILT**, micacous	815	
5		SS				810	12
		SS					9
10		SS				805	8
		SS			(SM) Medium dense mult-colored brown and white silty medium to fine **SAND**, micacous		11
15		SS				800	
		SS					21
20		SS			(PWR) PARTIALLY WEATHERED ROCK: Sampled as very dense tan and white silty coarse to fine **SAND** with rock fragments	795	50/5"
25		SS				790	50/6"

Boring was terminated at 29 feet below the existing ground surface.

Groundwater was encountered at 11.5 feet below the existing ground surface at the time of boring completing.

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-27**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILMER ENGINEERING, INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-28
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **826.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **5** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **14.5**

Logged By: **DP** Date Drilled: **3/1/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
		SS			Gravel Road = 4 inches / FILL	826.0	
		SS			FILL: Medium dense reddish brown clayey medium to fine **SAND** / SM	825	23
5		SS			RESIDUUM: Medium dense tan and brown silty medium to fine **SAND** / SM		24
		SS			Dense to very dense multi-brown and orange silty medium to fine **SAND** with rock fragments	820	80
10		SS					33
						815	
		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense and dense multi-brown and orange silty medium to fine **SAND** with rock fragments / PWR		50/3"

Auger refusal was encountered at 14.5 feet below the existing ground surface. Auger refusal was also encountered at adjacent offsets at 14 feet and 13 feet below the existing ground surface.

Groundwater was encountered at 11 feet below the existing ground surface at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-28**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-29
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **841.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **4** Overburden (ft): **11** Rock (ft): **9** Total Depth (ft): **20.0**

Logged By: **PL** Date Drilled: **5/2/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
		SS			FILL: Medium dense to loose brown and gray silty medium to fine **SAND** — FILL	841.0	
		SS				840	12
5		SS			RESIDUUM: Medium dense to dense brown, white and gray silty medium to fine **SAND** (micaceous) — SM		10
		SS				835	24
		SS					37
10					PARTIALLY WEATHERD ROCK: Sampled as very dense black and brown silty medium to fine **SAND** — PWR	830	50/6"
		NQ	60	52	ROCK: Moderately hard to hard gray and white biotite **GNEISS**		
15						825	
		NQ	100	60			
20							

Auger refusal was encountered at 11 feet below the existing ground surface.

An offset boring was performed 5 feet west from the original boring location and auger refusal was encountered at 10 feet below the existing ground surface.

Groundwater was not encountered at the time of boring completion.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-29**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-30
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **834.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **7** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **23.0**

Logged By: **PL** Date Drilled: **5/1/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Pavement System = 18 inches	834.0		
		SS			FILL: Medium dense brown and gray silty medium to fine **SAND** with decomposing organics including stumps, roots, and other plant remains — FILL			11
5		SS				830		10
		SS						3
10		SS			Firm to soft brown medium to fine sandy **CLAY** with decomposing organics	825		6
		SS			RESIDUUM: Medium dense dark gray and white silty medium to fine **SAND** — SM	820		11
15		SS						
		SS			PARTIALLY WEATHERED ROCK : Sampled as very dense gray and white silty coarse to fine **SAND** — PWR	815		50/5"
20		SS						50/0"
					Auger refusal was encountered at 23 feet below the existing ground surface.			
					Groundwater was encountered at 20 feet below the existing ground surface 24 hours after the boring completion.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-30**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. | WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-31
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **835.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **N/A** Samples: **10** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **41.0**

Logged By: **PL** Date Drilled: **5/1/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N-VALUE
		SS			Pavement System = 24 inches		835.0	
0		SS			FILL: Very loose to medium dense black silty medium to fine **SAND** with decomposing organics, debris and trash including stumps, roots, other plant remains and wires	FILL		6
		SS						6
5		SS					830	4
		SS						12
10		SS					825	10
					RESIDUUM: Loose to medium dense dark brown and gray silty medium to fine **SAND** (micaceous)	SM		
15		SS					820	8
20		SS					815	13
					Dense brown and gray silty medium to fine **SAND**	SM		
25		SS					810	39
		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense brown and gray silty coarse to fine **SAND**	PWR	805	50/6"
30								
		SS					800	50/5"
35								
		SS					795	50/3"
40					Auger refusal was encountered at 41 feet below the existing ground surface.			
					Groundwater was encountered at 18 and 17 feet below the existing ground surface at the time of boring completion and after 24 hours, respectivly.			

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-31**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMS ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-32
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **837.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **7** Overburden (ft): **24.5** Rock (ft): **10** Total Depth (ft): **34.5**

Logged By: **PL** Date Drilled: **7/23/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
					Pavemet System = 5 inches asphalt, 6 inches GAB	837.0	
		SS			FILL		
		SS			FILL: Firm dark brown medium to fine sandy **CLAY** with roots	835	7
5		SS					8
		SS			RESIDUUM: Stiff brown medium to fine sandy **SILT** ML	830	9
10		SS					11
					Medium dense to very dense brown and gray silty medium to fine **SAND** SM	825	
15		SS					14
						820	
20		SS					65
						815	
		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense gray and white silty medium to fine **SAND** PWR		50/1"
25						810	
		NQ	100	23	ROCK: Soft to hard gray GNEISS		
30						805	

Auger refusal was encountered at 24.5 feet below the existing ground surface.

Rock coring was terminated at 34.5 feet below the existing ground surface.

Groundwater was encounted at 22.5 feet below the existing ground surface at the time of boring completion and after 24 hours.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-32**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLOUGHBY ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-33
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: **--** Angle from Horizontal: **90** Surface Elevation (ft): **831.00** Station: **N/A**
Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**
Core Boxes: **N/A** Samples: **8** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **30.0**
Logged By: **DP** Date Drilled: **7/24/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
0					Pavement System = 12 inches asphalt	831.0		
		SS			FILL: Medium dense and loose black silty **SAND** with debris consisting of wood, metal, glass, wires, and tin cans. FILL	830		12
5		SS						21
		SS				825		15
10		SS						10
						820		
15		SS						10
						815		
20		SS						35
						810		
25		SS			PARTIALLY WEATHERED ROCK: Sampled as orange and tan silty medium to fine **SAND** PWR			50/5"
		SS				805		50/1"
30					Auger refusal was encountered at 30 feet below the existing ground surface.			

Groundwater was encountered at 18 feet and 16 feet below the existing ground surface at the time of boring completion and after 24 hours, respectively.

At the original boring location, auger refusal was encountered at a depth of 8 feet on possible debris. B-33 was drilled 10 feet north of the original location.

Debris fill blocked the bore hole preventing setting casing for rock coring. Boring B-33A was subsequently drilled at an offset location 6 feet west of B-33 for the purpose of rock coring.

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-33**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**	**HOLE No. B-33A**
Location: **Fulton County, Georgia**	Sheet 1 of 1
Project Number: **71.3801**	Location: **See Figure 2**

Azimuth: Angle from Horizontal: **90** Surface Elevation (ft): **831.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **0** Overburden (ft): **24** Rock (ft): **10** Total Depth (ft): **34.0**

Logged By: **DP** Date Drilled: **7/24/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Pavement System = 12 inches asphalt	831.0		
					FILL: Black silty **SAND** with debris consisting of wood, metal, glass, wires, and tin cans. **FILL**	830		
5						825		
10						820		
15						815		
20					PARTIALLY WEATHERED ROCK: Sampled as orange and tan silty medium to fine **SAND** **PWR**	810		
25		NQ	70	28	ROCK: Soft to hard gray GNEISS	805		
30						800		
					Auger refusal was encountered at 24 feet below the existing ground surface.			
					Rock coring was terminated at 34 feet below the existing ground surface.			
					This boring was drilled 6 feet west of B-33 for the purpose of rock coring. Rock coring could not be performed at B-33 because casing could not be installed due to debris fill blocking the bore hole.			

SAMPLER TYPE

SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD

HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-33A**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-34
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **833.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **12** Overburden (ft): **48.5** Rock (ft): **15** Total Depth (ft): **63.5**

Logged By: **PL** Date Drilled: **7/20/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)
0	SS			Pavement System = 6 incehs asphalt, 4 inches GAB	FILL	833.0
	SS			FILL: Loose to medium dense black silty medium to fine **SAND** with debris consisting of wood, metal, and roots.		
5	SS			Only 1" of recovery for samples at 3.5'-5', 6'-7.5', and 8.5'-10'. Debris blocked bottom of the spoon.		830
	SS					825
10	SS					
15	SS					820
						815
20	SS			RESIDUUM: Firm dark brown and black medium to fine sandy **CLAY**	CL	
25	SS			Medium dense to dense brown and gray silty medium to fine **SAND** (micaceous)	SM	810
30	SS					805
						800
35	SS			PARTIALLY WEATHERED ROCK: Sampled as very dense brown and tan silty medium to fine **SAND**	PWR	
	SS					795
40						
45	SS					790
	SS					785
50				ROCK: Soft to hard gray GNEISS		
	NQ	20	10			780
55						

STANDARD PENETRATION TEST DATA (blows/foot)

5 10 20 40 60 80

N-VALUE: 10, 5, 7, 9, 16, 6, 29, 40, 50/5", 50/1", 50/6", 50/0"

Continued Next Page

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-34**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLOUGHBY ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-34
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
						775		
60		NQ	93	67	ROCK: Hard to very hard gray GNEISS	770		
					Auger refusal was encountered at 48.5 feet below the existing ground surface. Rock coring was terminated at 63.5 feet below the existing ground surface. Groundwater was encountered at 17 feet below the existing ground surface 24 hours after boring completion			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-34**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-35
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **837.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **10** Overburden (ft): **39.5** Rock (ft): **10** Total Depth (ft): **49.5**

Logged By: **DP** Date Drilled: **7/25/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot)	N-VALUE
					Pavement System = 6 inches asphalt, 6 inches GAB — FILL	837.0		
		SS			FILL: Medium dense to very loose black silty medium to fine **SAND** with debris consisting of wood, metal, and glass	835		23
5		SS						5
		SS				830		3
					Firm brown and gray medium to fine sandy **CLAY** wih debris consisting of plant fibers — FILL			
10		SS						6
					RESIDUUM: Medium dense brown and orange silty medium to fine **SAND** (micaceous) — SM	825		
15		SS						12
						820		
20		SS						14
						815		
25		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense brown and orange silty medium to fine **SAND** — PWR			50/6"
		SS				810		50/5"
30								
		SS				805		50/5"
35								
		SS				800		50/1"
40					ROCK: Medium to very hard gray GNEISS			
		NQ	97	41		795		
45								
						790		
					Auger refusal was encountered at 39.5 feet below the existing ground surface.			

Continued Next Page

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-35**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLAMS ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-35
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
					Rock coring was terminated at 49.5 feet below the existing ground surface. Groundwater was encountered at 20 feet and 18 feet below the existing ground surface at the time of boring completion and after 24 hours, respectively. Boring was first offset 6 feet north from the original location due to existing slope. Auger refusal was encountered at 7 feet below the existing ground surface at that location, and boring was then offset another 5 feet to the east.			

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-35**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-36
Sheet 1 of 2
Location: **See Figure 2**

Azimuth: Angle from Horizontal: **90** Surface Elevation (ft): **836.00** Station: **N/A**
Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**
Core Boxes: **1** Samples: **14** Overburden (ft): **59** Rock (ft): **10** Total Depth (ft): **69.0**
Logged By: **DP** Date Drilled: **7/25/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N-VALUE
0				Pavement System = 12 inches asphalt		836.0	
0	SS			FILL: Dense to loose black silty **SAND** with debris and trash such as glass	FILL	835	80*
5	SS			*Initial SPT N-value amplified by debris	FILL		16
5	SS			Medium dense and loose black silty **SAND** with debris and trash such as glass, crushed concrete, wood, cardboard, and paper		830	8
10	SS						19
10						825	
15	SS						12
15						820	
20	SS			Very loose black silty **SAND**	FILL		3
20				RESIDUUM: Medium dense orange and tan medium to fine sandy **SILT** (micaceous)	ML	815	
25	SS						16
30	SS					810	15
35	SS			Very dense tan and reddish brown silty medium to fine **SAND** with rock fragements	SM	805	75
40	SS					800	52
45	SS			PARTIALLY WEATHERED ROCK: Sampled as Very dense reddish brown, tan, black and white silty coarse to fine **SAND** with rock fragments	PWR	795	50/5"
50	SS					790	50/4"
55	SS					785	50/1"

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

Continued Next Page

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-36**

SPTN_LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-36
Sheet 2 of 2
Location: **See Figure 2**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION (Continued)	ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
		SS				780		50/1"
60		NQ	50	0	ROCK: Moderatley hard to hard GNEISS	775		
65		NQ	100	72		770		

Auger refusal was encountered at 59 feet below the existing ground surface.

Rock coring was terminated at 69 feet below the existing ground surface.

Groundwater was encountered at 20 feet and 17 feet below the existing ground surface at the time of boring completion and after 24 hrs, respectively.

Shallow Auger refusal was encountered on the debris fill at the original boring location and one offset location within 10 feet of B-36 at depths of 8 and 12 feet below the existing ground surface.

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-36**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-37
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **844.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **6** Overburden (ft): **23** Rock (ft): **15** Total Depth (ft): **38.0**

Logged By: **PL** Date Drilled: **7/23/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
	SS			Pavement System = 3 inches asphalt, 9 inches GAB — FILL	844.0	
	SS			FILL: Firm dark brown medium to fine sandy **CLAY** with metal debris — FILL	840	8
5	SS			Medium dense dark brown and black silty medium to fine **SAND** — SM		11
	SS			RESIDUUM: Medium dense to very dense dark brown and black silty medium to fine **SAND**	835	32
10	SS					62
	SS				830	43
15						
	SS			PARTIALLY WEATHERED ROCK: Sampled as very dense gray and white silty medium to fine **SAND** — PWR	825	50/6"
20						
	NQ	17	0	ROCK: Soft to medium hard GNEISS	820	
25						
					815	
30						
	NQ	90	50	Hard to very hard GNEISS	810	
35						

Auger refusal was encountered at 23 feet below the existing ground surface.

Rock coring was terminated at 38 feet below the existing ground surface.

No groundwater was encountered at the time of boring completion. Boring had caved to 19 feet after 24 hours.

STANDARD PENETRATION TEST DATA (blows/foot)
5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-37**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WELLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-38
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **834.00** Station: **N/A**
Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**
Core Boxes: **N/A** Samples: **16** Overburden (ft): **N/A** Rock (ft): **N/A** Total Depth (ft): **43.5**
Logged By: **DP** Date Drilled: **7/27/12**

VERTICAL DEPTH (ft)	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N-VALUE
0				Pavement System = 12 inches asphalt	834.0	
	SS			FILL: Very stiff black and brown medium to fine sandy **CLAY** with decaying plant matter — FILL		18
	SS				830	7
5	SS			Highly organic soil with decaying leaves and other plant matter (no soil) — FILL		6
	SS			*High SPT N-value likely due to debris in fill	825	20*
10	SS					3
	SS			Soft black and grey clayey medium to fine **SAND** with decaying plant matter — FILL / CL	820	7
15	SS			RESIDUUM: Firm to soft tan and grey medium to fine sandy **CLAY**/clayey **SAND** (micaceous)		4
	SS				815	9
20	SS			Loose orange and tan silty coarse to fine **SAND** — SM		7
	SS				810	19
25	SS			Medium dense to dense reddish orange brown and black silty medium to fine **SAND** with seams of white silty SAND (slightly micaceous) — SM		14
	SS				805	21
30	SS					33
	SS			PARTIALLY WEATHERED ROCK: Sampled as very dense reddish orange, brown, and black silty medium to fine **SAND** with rock fragments — PWR	800	50/5"
35	SS					50/5"
					795	
40	SS					50/0"
				Auger refusal was encountered at 43.5 feet below the existing ground surface.		
				Groundwater was encountered at 14 feet and 15 feet below the existing ground surface at the time of boring completion and after 24 hours, respectively.		

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-38**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-39
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **816.00** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **5** Overburden (ft): **11.5** Rock (ft): **10** Total Depth (ft): **21.5**

Logged By: **PL** Date Drilled: **10/3/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	STANDARD PENETRATION TEST DATA (blows/foot) 5 10 20 40 60 80	N-VALUE
		SS			Topsoil = 2 inches	CL	816.0		
		SS			RESIDUUM: Very stiff reddish brown medium to fine sandy **CLAY** with rock fragments		815		20
5		SS			Very dense to medium dense light brown and reddish brown silty medium to fine **SAND**	SM	810		50/2"
		SS							55
10		SS			PARTIALLY WEATHERED ROCK: Sampled as very dense gray silty medium to fine **SAND** with rock fragments	PWR	805		23
15		NQ	65	17	BEDROCK: Medium hard to hard gray **GNEISS**		800		50/4"
20							795		

Aguer refusal was encountered at 11.5 feet below the existing ground surface.

Rock coring was terminated at 21.5 feet below the existing ground surface.

Groundwater was not encountered at the time of boring completion.

SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-39**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

WILLMER ENGINEERING INC. WE

Project: **Liddell Drive Equalization Project**
Location: **Fulton County, Georgia**
Project Number: **71.3801**

HOLE No. B-40
Sheet 1 of 1
Location: **See Figure 2**

Azimuth: -- Angle from Horizontal: **90** Surface Elevation (ft): **812.50** Station: **N/A**

Drilling Equipment: **CME 45** Drilling Method: **HSA Manual Hammer**

Core Boxes: **1** Samples: **7** Overburden (ft): **23** Rock (ft): **10** Total Depth (ft): **33.0**

Logged By: **PL** Date Drilled: **10/4/12**

VERTICAL DEPTH (ft)	GRAPHIC LOG	SAMPLE TYPE	REC%	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N-VALUE
0		SS			Topsoil = 2 inches	FILL	812.5	
		SS			FILL: Medium dense to loose brown silty medium to fine **SAND** with gravels		810	19
5		SS						10
		SS					805	8
10		SS			ALLUVIUM: Very soft dark gray medium to fine sandy **CLAY**	CL		2
		SS			Loose light gray silty coarse to fine **SAND** with wood fragments	SM	800	10
15		SS			Blow counts possibly magnified by wood fragments			50/5"
		SS			PARTIALLY WEATHERED ROCK: sampled as very dense light brown silty medium to fine **SAND**	PWR	795	50/4"
20		SS						
		SS			BEDROCK: Medium hard to hard gray and brown **SCHIST** and **GNEISS**		790	50/0"
25		NQ	97	33				
							785	
30								
							780	

STANDARD PENETRATION TEST DATA (blows/foot): 5 10 20 40 60 80

Auger refusal was encountered at 23 feet below the existing ground surface.

Rock coring was terminated at 33 feet below the existing ground surface.

Boring was offset 15 feet west due to the existing utilities.

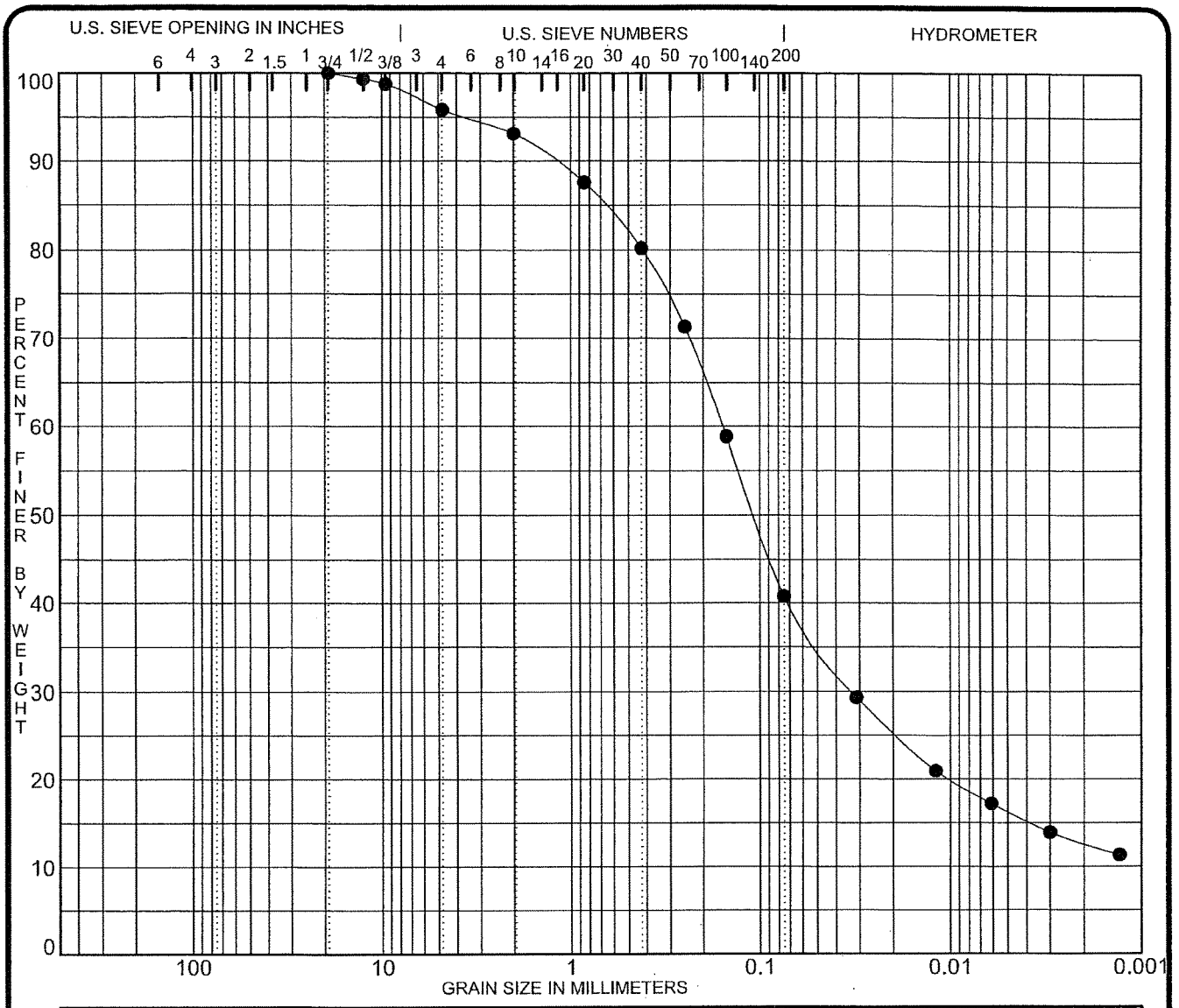
SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
NQ - Rock Core, 1-7/8"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-40**

SPTN LIDDELL DRIVE EQUALIZATION.GPJ 10/9/12

APPENDIX II



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Soil Description	MC%	LL	PL	PI	Cc	Cu
● **B-10 (1-5 ft)**	**Brown silty, clayey medium to fine SAND (SC-SM)**	**6.3**	**26**	**20**	**6**		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-10 (1-5 ft)**	**19.00**	**0.16**	**0.033**		**4.1**	**55.1**	**28.1**	**12.7**

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

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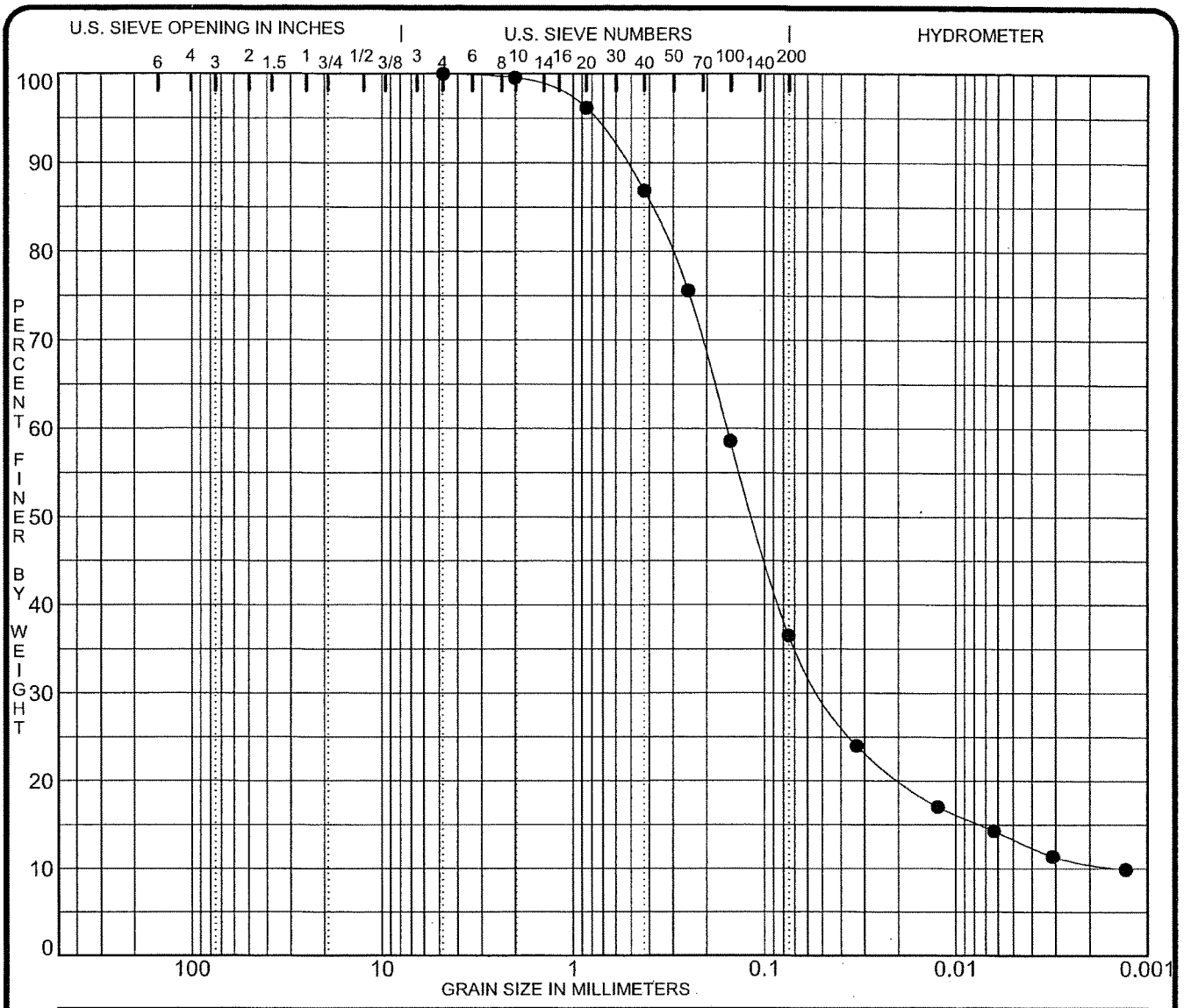
GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification	Soil Description	MC%	LL	PL	PI	Cc	Cu
●	**B-11 (18.5-20 ft)**	**Brown silty medium to fine SAND (micaceous) (SM)**	**23.8**	**31**	**26**	**5**	**11.00**	**113.1**

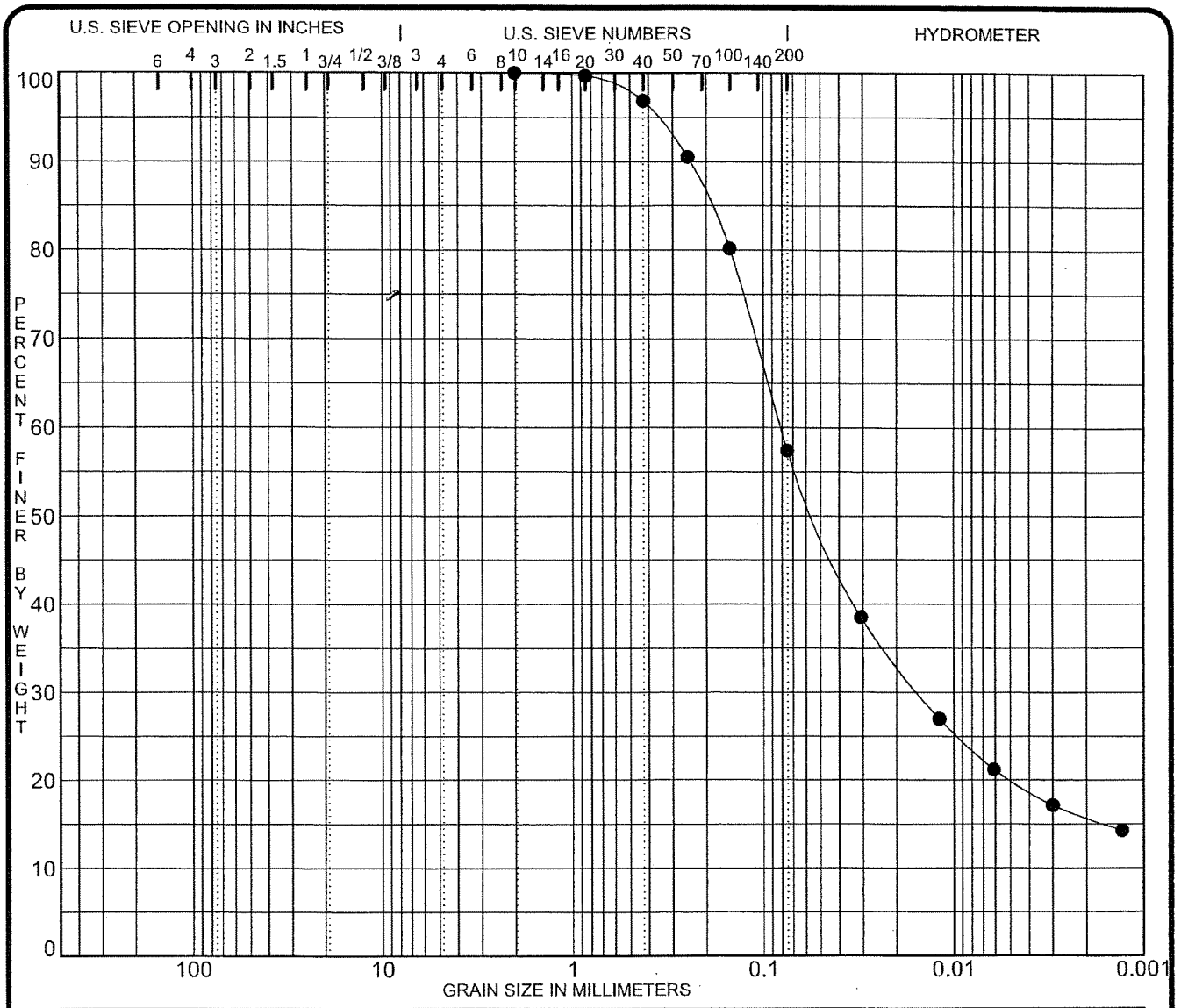
	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-11 (18.5-20 ft)**	**4.75**	**0.16**	**0.049**	**0.0014**	**0.0**	**63.5**	**25.9**	**10.6**

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

WILLMER ENGINEERING INC. WE

GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Soil Description	MC%	LL	PL	PI	Cc	Cu
● B-15A (3.5-5 ft)	Brown fine sandy SILT (micaceous) (ML)	36.3	37	29	8		

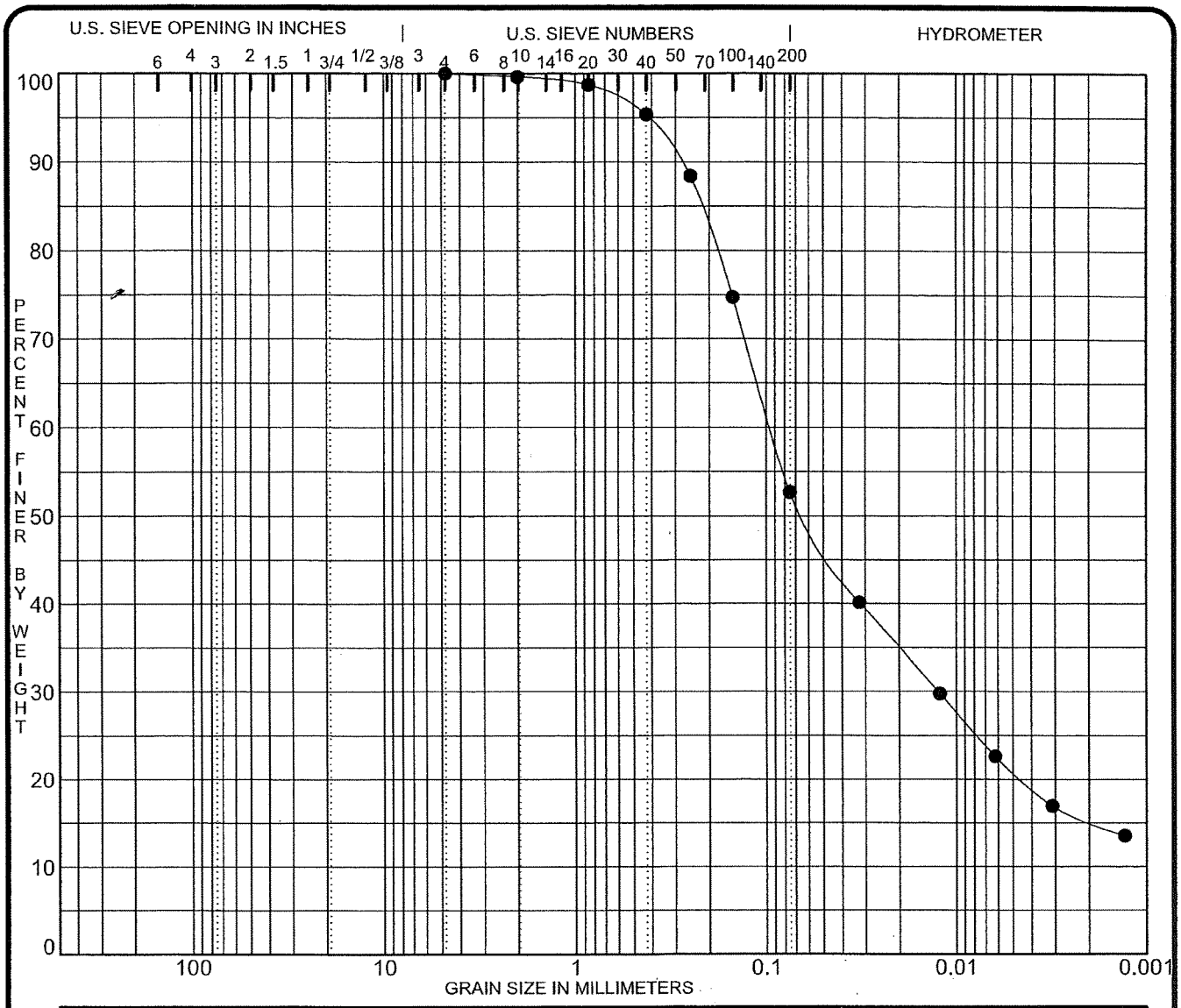
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-15A (3.5-5 ft)	2.00	0.08	0.015		0.0	42.6	41.7	15.8

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

WILLMER ENGINEERING INC. WE

GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Soil Description	MC%	LL	PL	PI	Cc	Cu
● B-16 (3.5-5 ft)	Brown fine sandy SILT (micaceous) (ML)	49.4	49	32	17		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-16 (3.5-5 ft)	4.75	0.09	0.012		0.0	47.3	37.5	15.2

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

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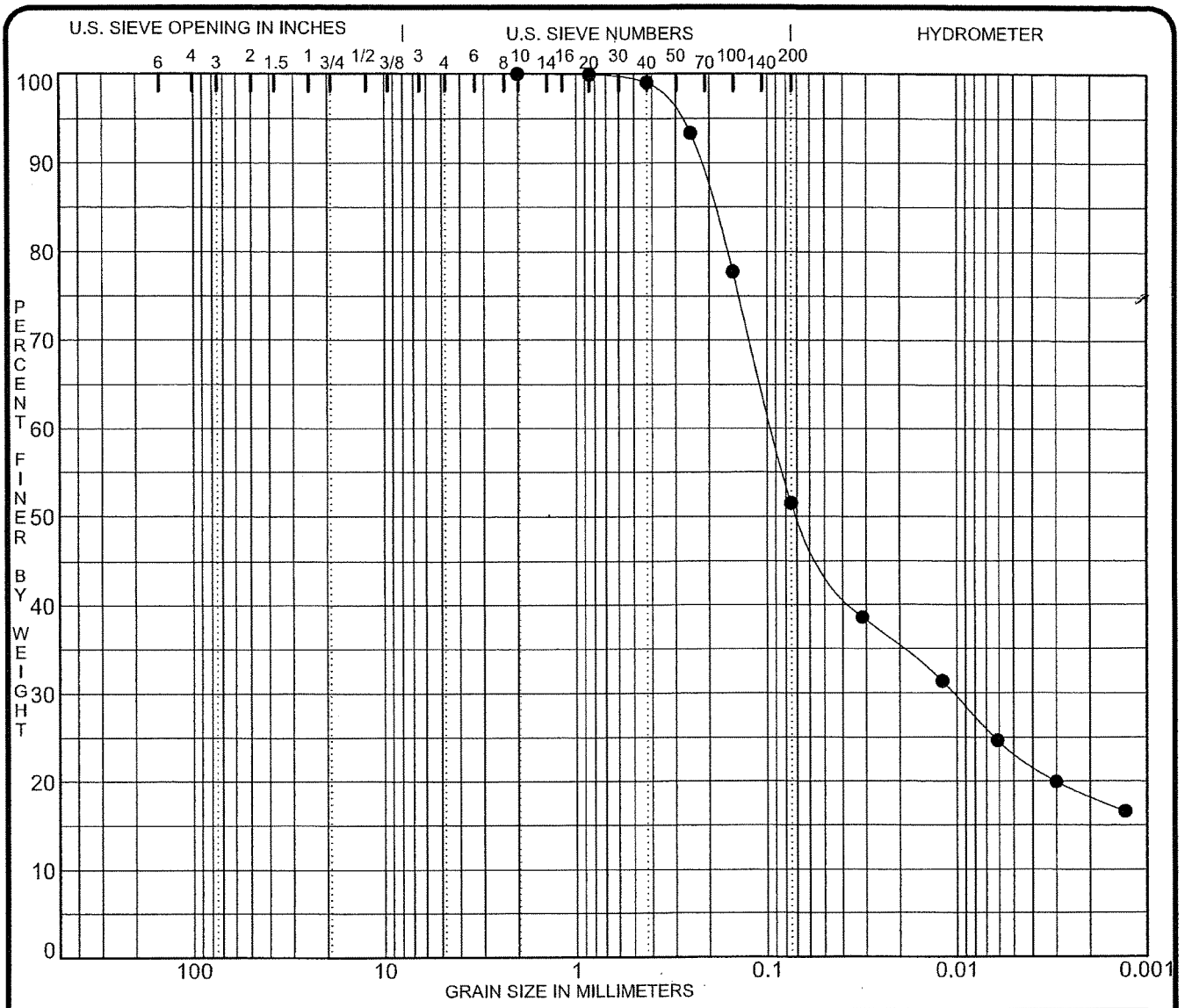
GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Soil Description	MC%	LL	PL	PI	Cc	Cu
● B-17 (8.5-10 ft)	Gray fine sandy lean CLAY (micaceous) (CL)	25.5	25	17	8		

Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-17 (8.5-10 ft)	2.00	0.09	0.010		0.0	48.5	33.2	18.3

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

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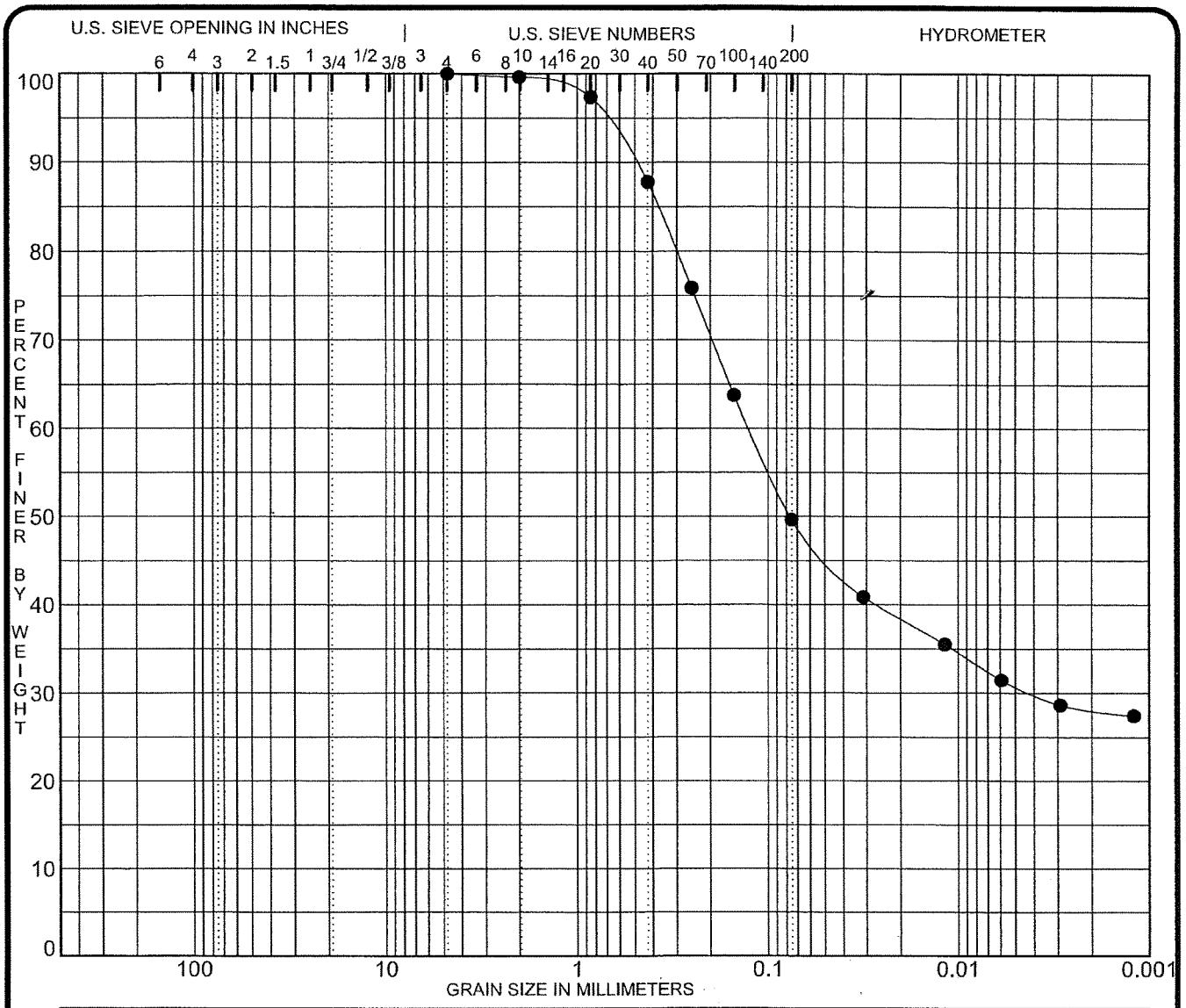
GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Soil Description	MC%	LL	PL	PI	Cc	Cu
● **B-13B (13-15 ft)**	**Brown clayey medium to fine SAND (micaceous) (SC)**	**22.6**	**28**	**16**	**12**		

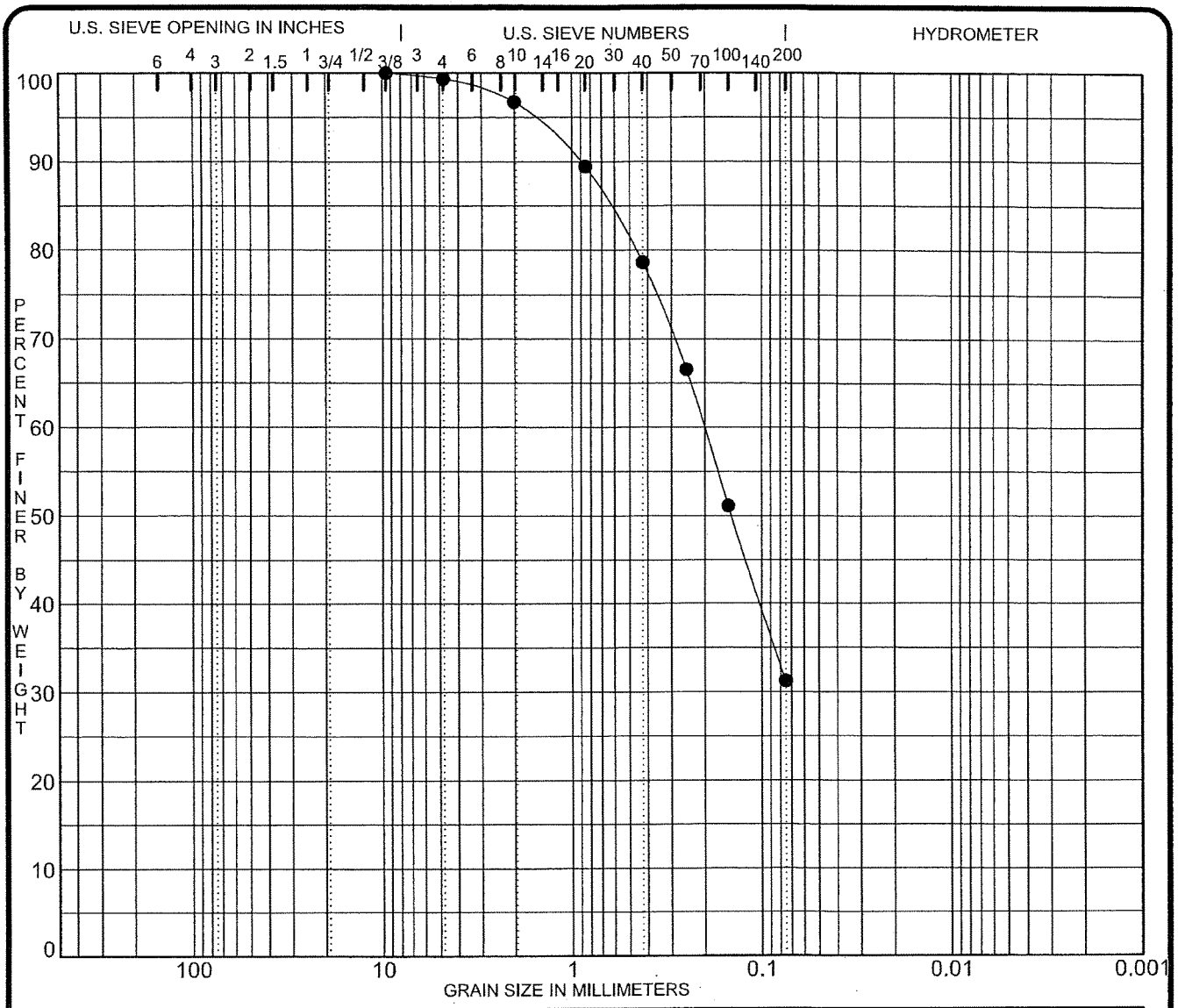
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-13B (13-15 ft)**	**4.75**	**0.12**	**0.004**		**0.0**	**50.3**	**21.5**	**28.1**

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

WILLMER ENGINEERING INC. WE

GRAIN SIZE DISTRIBUTION



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification	Soil Description	MC%	LL	PL	PI	Cc	Cu
● B-4 (25-26.5 ft)	Brown silty medium to fine SAND (micaceous)	42.8					

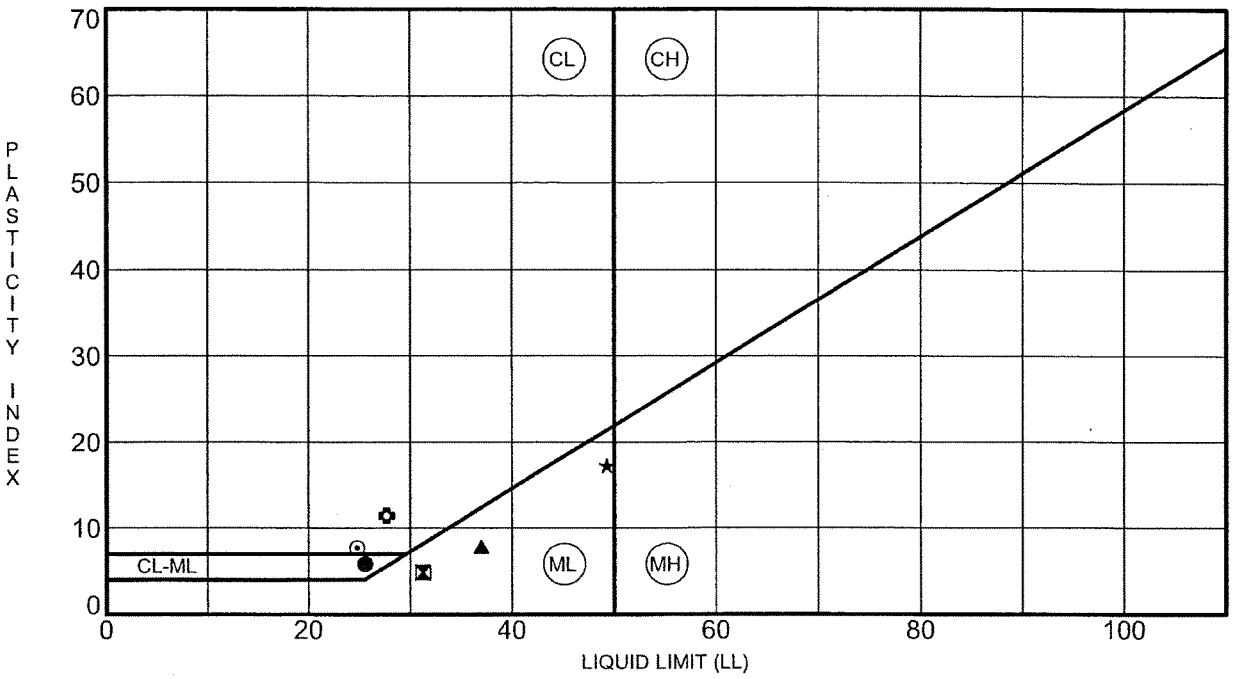
Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 (25-26.5 ft)	9.50	0.20			0.7	68.1	31.3	

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

WILLMER ENGINEERING INC. WE

GRAIN SIZE DISTRIBUTION



Specimen Identification	LL	PL	PI	Fines	Classification
● B-10 (1-5 ft)	26	20	6	40.8	Brown silty, clayey medium to fine SAND (SC-SM)
⊠ B-11 (18.5-20 ft)	31	26	5	36.5	Brown silty medium to fine SAND (micaceous) (SM)
▲ B-15A (3.5-5 ft)	37	29	8	57.4	Brown fine sandy SILT (micaceous) (ML)
★ B-16 (3.5-5 ft)	49	32	17	52.7	Brown fine sandy SILT (micaceous) (ML)
⊙ B-17 (8.5-10 ft)	25	17	8	51.5	Gray fine sandy lean CLAY (micaceous) (CL)
✿ B-13B (13-15 ft)	28	16	12	49.7	Brown clayey medium to fine SAND (micaceous) (SC)

PROJECT **Liddell Drive Equalization Project**
Fulton County, Georgia

JOB NO. **71.3801**
DATE **4/24/12**

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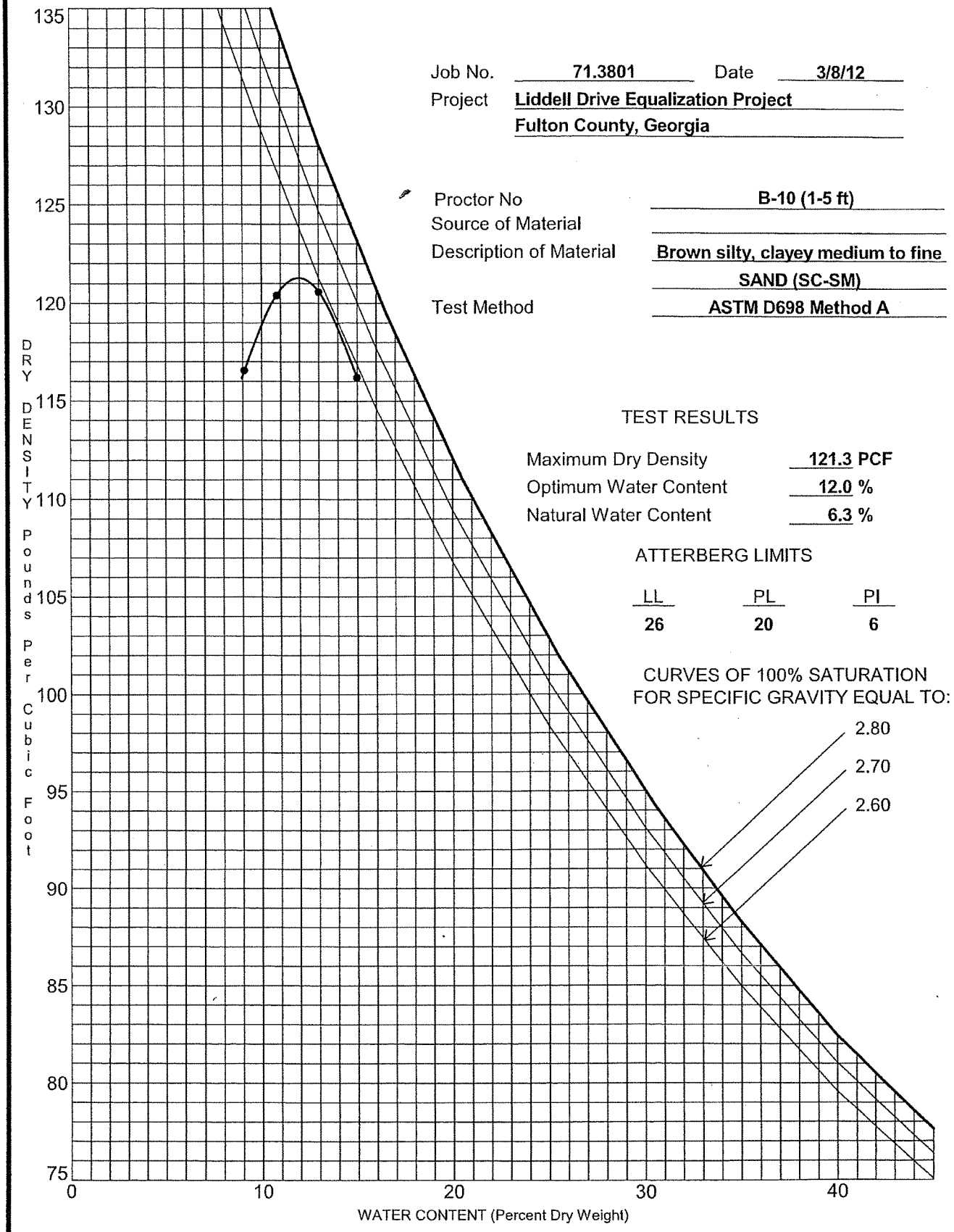
ATTERBERG LIMIT RESULTS



Job No. 71.3801 Date 3/8/12

Project **Liddell Drive Equalization Project**
Fulton County, Georgia

Proctor No	**B-10 (1-5 ft)**
Source of Material	
Description of Material	**Brown silty, clayey medium to fine SAND (SC-SM)**
Test Method	**ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**121.3** PCF
Optimum Water Content	**12.0** %
Natural Water Content	**6.3** %

ATTERBERG LIMITS

LL	PL	PI
26	20	6

CURVES OF 100% SATURATION FOR SPECIFIC GRAVITY EQUAL TO:

WILLAMOR ENGINEERING INC. WE

MOISTURE-DENSITY RELATIONSHIP

WILLMER ENGINEERING INC. WE

California Bearing Ratio Test Report

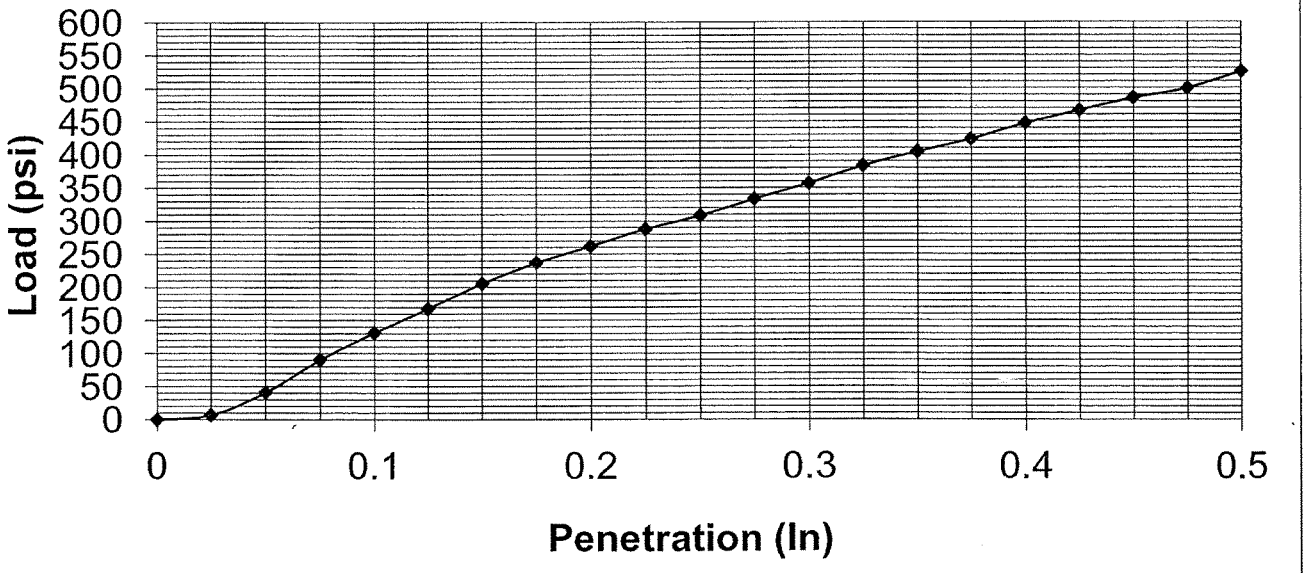
ASTM D1883-99

Project	Liddell Drive Equaliztion Project	Project Number		71.3801	Date	4/24/2012
Lab Number	6998	SAMPLE NO.		B-10	Elevation/Depth	1'-5'
Proctor Procedure	ASTM D698 Method A	Maximum Dry Density (pcf)		121.3	Optimum Water Content (%)	12.0
Compacted Wet Density (pcf)	135.8	Compacted Dry Density (pcf)		121.4	Soaked Dry Density (pcf)	122.5
Soil Description	Brown silty, clayey medium to fine SAND (SC-SM)	Compacted Water Content (%)			Soaked Water Content (%)	
		Before Compaction		11.94	Top 1"	14.63
		After Compaction		11.94	Average	13.84
CBR Condition	Soaked	Surcharge Weight		25 Lbs	Swell (in.)	0.004
Index Properties	Percent Fines	40.8	G_S	N/A	Reviewed	DP
	LL	26	PI	6		

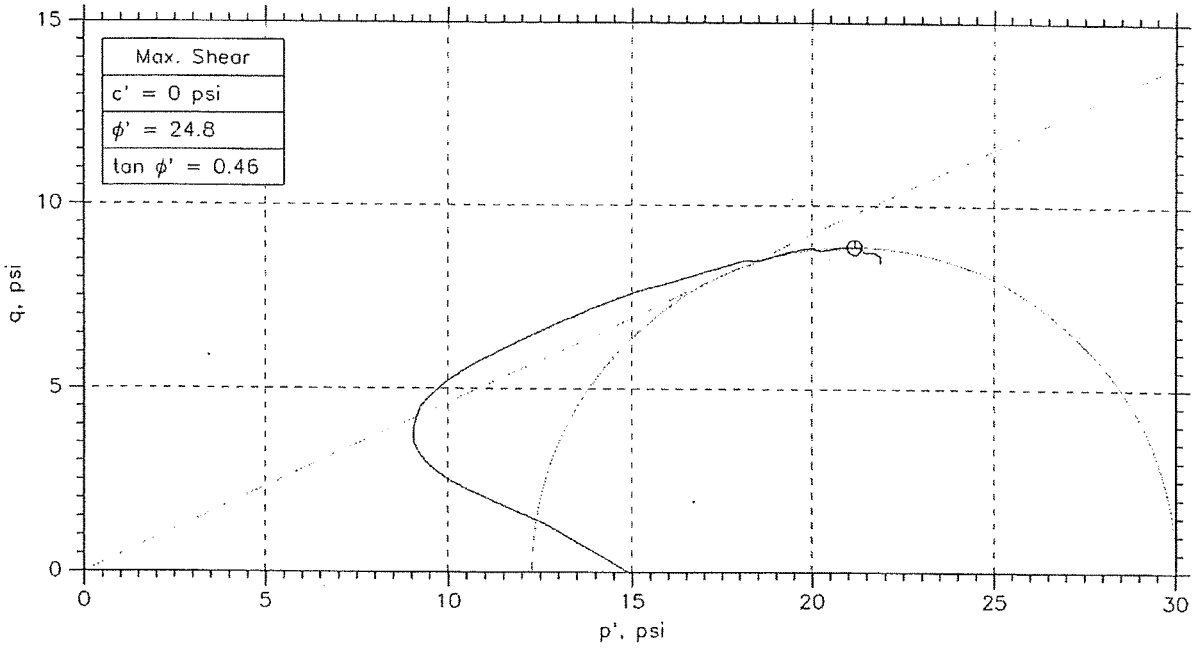
CBR Value	(.1) 16.7, (.2) 19.1

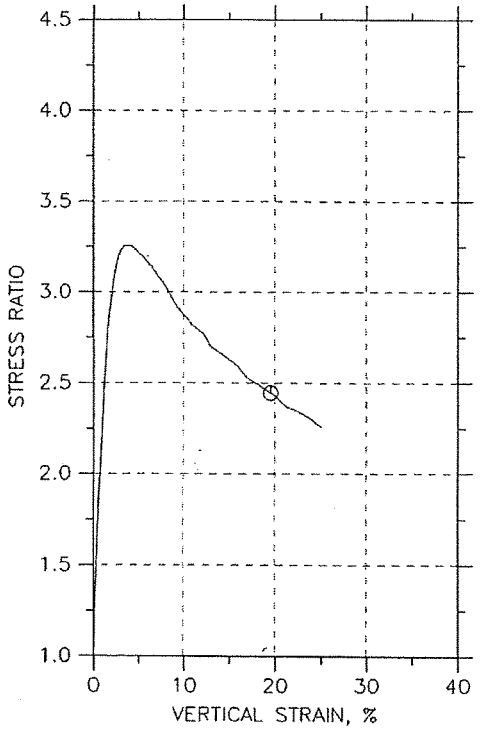
COMPACTION		
	Required	Achieved
Dry Density	100%	100%
Moisture	opt	opt

Load-Penetration Curve



CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767





Symbol		⊙			
Sample No.		B-4			
Test No.		7036			
Depth		25'-26.5'			
Initial	Diameter, in	2.827			
	Height, in	5.101			
	Water Content, %	42.8			
	Dry Density, pcf	79.5			
	Saturation, %	104.9			
	Void Ratio	1.08			
Before Shear	Water Content, %	40.9			
	Dry Density, pcf	79.44			
	Saturation*, %	100.0			
	Void Ratio	1.08			
	Back Press., psi	76.			
Ver. Eff. Cons. Stress, psi		14.93			
Shear Strength, psi		8.874			
Strain at Failure, %		19.5			
Strain Rate, %/min		0.08			
B-Value		0.95			
Estimated Specific Gravity		2.65			
Liquid Limit		---			
Plastic Limit		---			

WE

Project: Liddell Drive Equlization

Location: Fulton County, Georgia

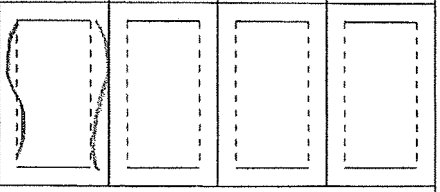
Project No.: 71.3801

Boring No.: B-4

Sample Type: Shelby Tube

Description: Brown silty fine SAND (micaceous)

Remarks: ASTM D4767

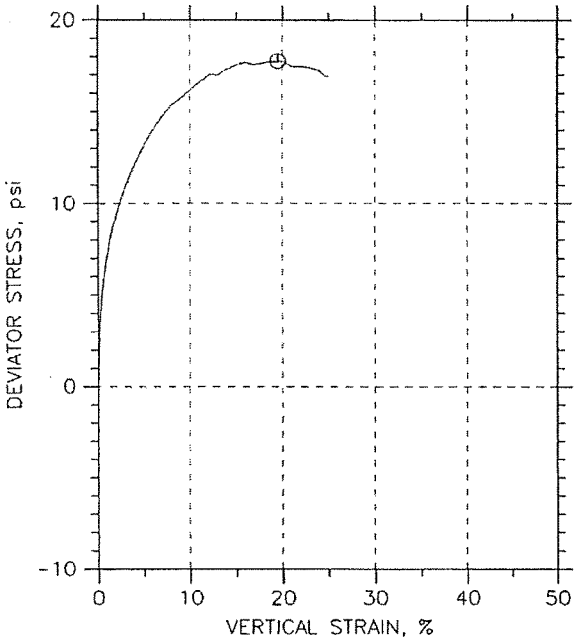


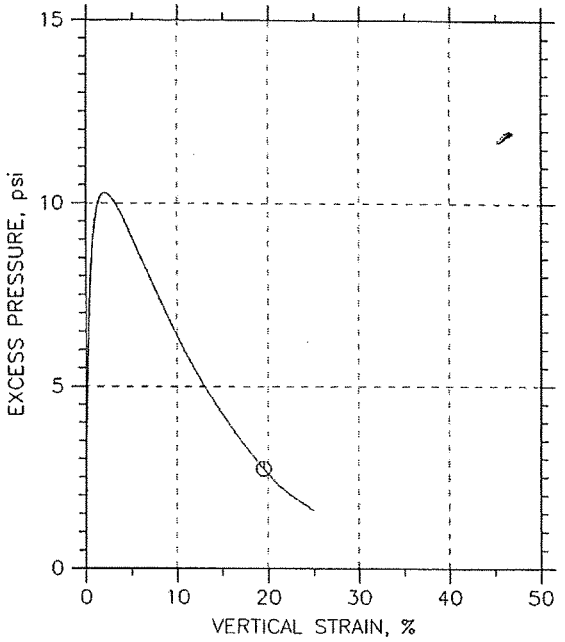
Phase calculations based on start and end of test.

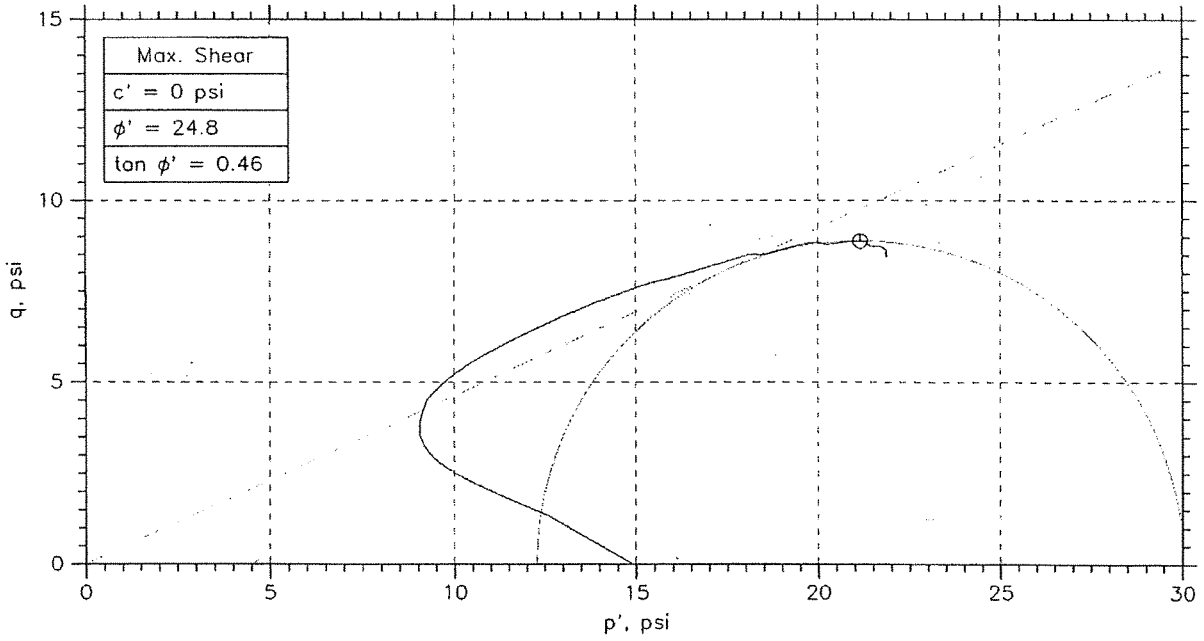
* Saturation is set to 100% for phase calculations.

Mon, 23-APR-2012 09:28:17

CONSOLIDATED UNDRAINED TRIAXIAL TEST by ASTM D4767







Project: Liddell Drive Equlization	Location: Fulton County, Georgia	Project No.: 71.3801
Boring No.: B-4	Tested By: K.Shah	Checked By: DP
Sample No.: B-4	Test Date: 3-29-2012	Depth: 25'-26.5'
Test No.: 7036	Sample Type: Shelby Tube	Elevation: 810.5'-812'
Description: Brown silty fine SAND (micaceous)		
Remarks: ASTM D4767		

Mon, 23-APR-2012 09:28:17

WILLMER ENGINEERING INC. | WE

October 30, 2012

VIA E-MAIL

Atlanta Services Group
c/o Don Fry, PE
Engineering Design Technologies, Inc.
1705 Enterprise Way
Suite 200
Marietta, GA 30067

SUBJECT: **Addendum No. 1**
Subsurface Exploration and Geotechnical Engineering Evaluation
Liddell Drive Equalization Project
Atlanta, Fulton County, Georgia
Willmer Project No. 71.3801

Dear Mr. Fry:

Willmer Engineering Inc. (Willmer) is pleased to provide this Addendum No. 1 to our revised report of subsurface exploration and geotechnical engineering evaluation (dated October 9, 2012) for the proposed Liddell Drive Equalization Project in Atlanta, Georgia. This addendum includes the following items: (i) recommendations for retaining wall design parameters, (ii) recommendations for undercut and replacement of soils for retaining wall footing, (iii) estimated settlement along the retaining wall, and (iv) pavement recommendations. This addendum is not a stand-alone document; it should be read in conjunction with our revised report for this project dated October 9, 2012.

RETAINING WALLS

No borings were performed specifically for Retaining Walls A or B. Borings B-25, B-26, B-27, B-28, and B-39 were drilled from 10 feet to 150 feet away from the proposed retaining walls. Based on subsurface conditions at these boring, we recommend the following:

Retaining Wall Design Parameters

Based on wall profiles, borrow fill soils will likely be used to backfill between Walls A and B. The borrow source for the site has not been selected yet; therefore, strength properties of the fill to be retained by the walls is not known at this time. It is assumed the borrow material for fill soils will be silty sand. Once a borrow source is selected for this project, laboratory tests should be performed on the borrow material to confirm that the design parameters below are achievable. For silty sand fill soils compacted to at least 95 percent of the Standard Proctor (ASTM D 698) maximum dry density, the following soil design parameters may be used for retaining wall evaluation/design:

- Friction Angle for Backfill — 30 degrees
- Cohesion Intercept — 0 psf
- Active Earth Pressure Coefficient (K_a) — 0.33
- At-rest Pressure Coefficient (K_o) — 0.5
- Passive Earth Pressure Coefficient (K_p) — 3*

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P: 770.939.0089
F: 770.939.4299
www.willmerengineering.com

- Unit Weight of Soil as Placed 125 pcf
- Equivalent Active Fluid Pressure 42 pcf
- Equivalent Passive Fluid Pressure 375 pcf*
- Equivalent At-rest Fluid Pressure 63 pcf
- Coefficient of Sliding Friction 0.35*

*In the design calculations, the resisting forces computed using the above recommended passive earth pressure coefficient, equivalent passive fluid pressure, and coefficient of sliding friction should be reduced using a safety factor of 1.5.

Undercut and Replacement for Retaining Walls

For Wall A (Station 0+90± to 3+00±) and Wall B (Station 1+75± to end of wall), soft alluvial soils are likely to be encountered below the wall footing. We recommend that the soft alluvial soils below the wall footings be undercut and replaced with engineered fill or compacted graded aggregate base (GAB). Based on Boring B-26 the amount of undercut is expected to be 8± feet. The depth of undercut will vary along the wall alignments. All subsurface soils should be inspected by the project geotechnical engineer to confirm suitable bearing conditions. As recommended in the 'Site and Subgrade Preparation' and 'Engineered Fill' sections of the revised report dated October 9, 2012 report, all fill soils used should be compacted to at least 95 percent of the Standard Proctor maximum dry density. The compaction moisture content should be maintained at Standard Proctor optimum moisture content plus or minus 3 percent. If GAB is used, the GAB should be compacted to 100 percent of the Standard Proctor maximum dry density. It should also be noted that at the time of boring, groundwater was encountered at elevations within 1 foot of the bottom of the wall footing. Hence, dewatering will be required to complete the excavation and backfilling.

Settlement of Retaining Walls

Based on the elevations at the boring locations, wall footings will likely bear in residual soils or in soft alluvial soils. As indicated in the Undercut and Replacement section above, soft alluvial soils below the wall footings should be undercut and replaced with engineered fill or compacted GAB. An allowable bearing pressure of 3,000 psf is recommended for use in the design of retaining wall footings. The width of the spread footings will vary with the height of the wall. For the maximum footing width of 13.9 feet, the settlement under a bearing pressure of 3000 psf is estimated to be less than 1 inch.

PAVEMENT DESIGN

We understand that a pavement section consisting of 3.5 inches of asphaltic concrete underlain by 6 inches of GAB has been proposed by Atlanta Services Group (ASG). The design of a flexible pavement section is based on traffic information provided to us by ASG, and an estimated Soil Support Value of 2.0, for Fulton County, used for the subbase material. The fill soils are assumed to be silty sand and laboratory tests should be performed on the fill material to confirm that the Soil Support Value used in design is achievable. The anticipated traffic volume is approximately two passenger vehicles per week and a loaded single unit truck twice

year design life. Based on the traffic volume provided, a pavement section of 3.5 inches of asphaltic concrete underlain by 6 inches of GAB is adequate.

As recommended in the 'Site and Subgrade Preparation' and 'Engineered Fill' sections of the revised report dated October 9, 2012 report, all fill soils used for site grading should be compacted to at least 95 percent of the Standard Proctor maximum dry density, and under roadway/pavement areas, we recommend that the final 12-inches below the pavement be compacted to 98% of the Standard Proctor maximum dry density (ASTM D698).The compaction moisture content should be maintained at Standard Proctor optimum moisture content plus or minus 3 percent. The GAB should be compacted to 100 percent of the Standard Proctor maximum dry density.

We greatly appreciate the opportunity to be of service to you on this project. Please contact us if you have any questions concerning this report or require further assistance.

Sincerely,

WILLMER ENGINEERING INC.

Daniel C. Pitts, EIT
Staff Geotechnical Engineer

James L. Willmer, PE
Executive Vice President/Principal Consultant

Sujit K. Bhowmik, PhD, PE
Chief Engineer

The original of this document was signed and sealed by James L. Willmer, PE, Registration No. 10780 on October 30, 2012.

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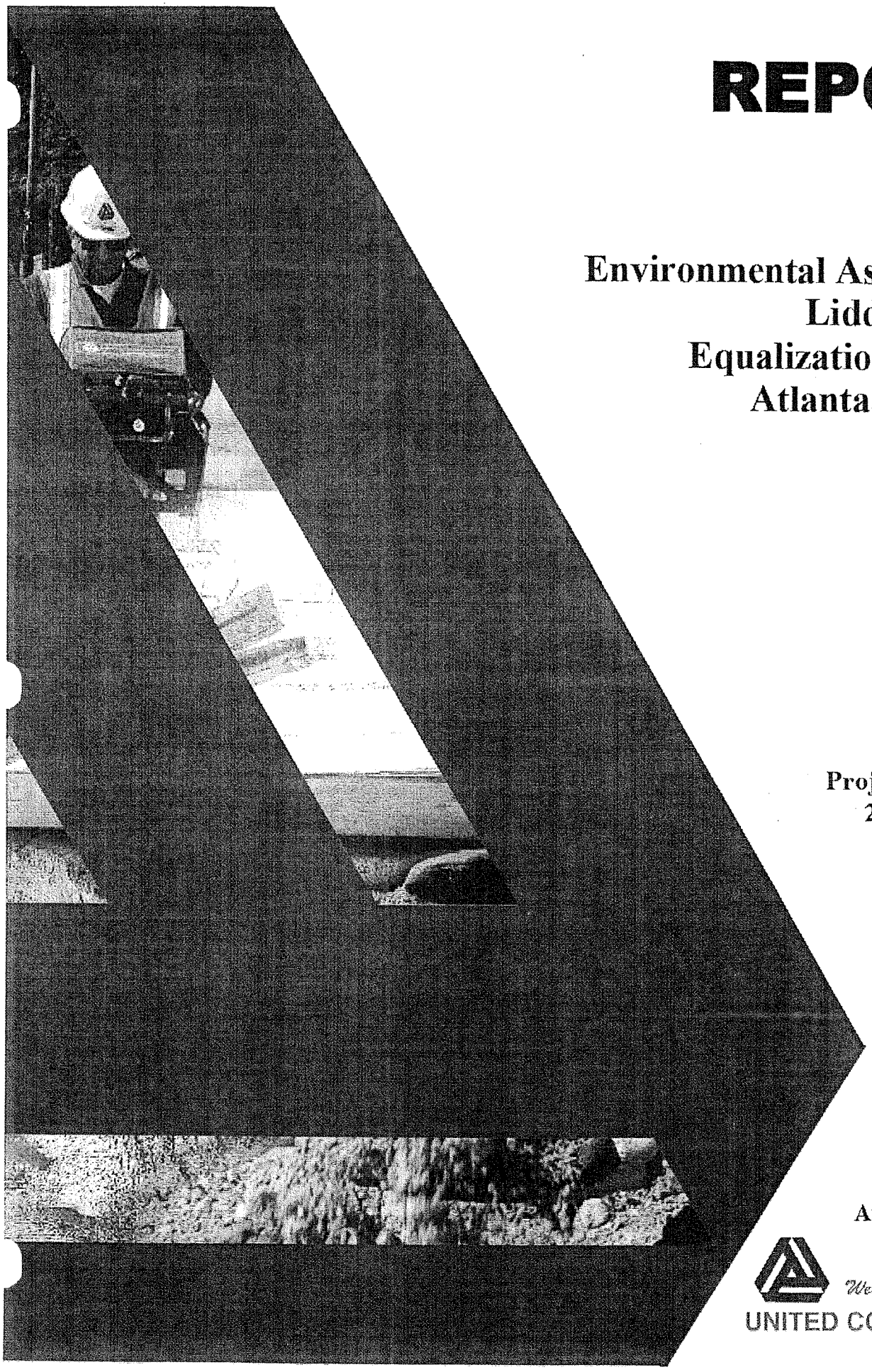

REPORT

Phase II Environmental Assessment Liddell Drive Equalization Project Atlanta, Georgia

Project Number
2012.3532.01

August 31, 2012

We're here for you
UNITED CONSULTING

We're here for you
UNITED CONSULTING

August 31, 2012

Mr. Stephen Lathrop, P.E.
Atlanta Services Group-Jacobs
6801 Governors Lake Parkway
Norcross, GA 30071

Via e-mail: Stephen.Lathrop@jacobs.com

RE: Report of Phase II Environmental Assessment
Liddell Drive Equalization Project
Atlanta, Georgia
Project No. 2012.3532.01

Dear Mr. Lathrop:

United Consulting is pleased to submit this report of our Phase II Environmental Assessment for the above-referenced project. We appreciate the opportunity to assist you with this project and look forward to working with you again. Please contact us if you have any questions or if we can be of further assistance.

Sincerely,

UNITED CONSULTING

Russell C. Griebel, P.G., C.P.G.
Associate Environmental Specialist

Scott D. Smelter
Principal

BNB/RCG/SDS/tl

http://ucblade10/sites/Geotechenv/7373/2012.3532.01/Environmental Documents/Phase II/2012.3532.01.ea2.doc

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EXECUTIVE SUMMARY[1]

United Consulting has completed a Phase II Environmental Assessment (Phase II) on the **Liddell Drive Equalization Project**, in Atlanta, Fulton County, Georgia. The area of this Phase II was limited to the direct areas of a planned equalization tank. There were two areas assessed, Areas A and B, with B being the latest location for the planned tank. This is hereafter referred to in this report as the Project Site. The location and layout of the Project Site is shown on Figures 1 and 2, respectively. The results from this investigation are briefly summarized below. The text of the report should be reviewed for a discussion of these items.

1. Four test pits[2], designated TP-1 thru TP-4, were excavated on the Project Site in Area A to facilitate soil sampling. One existing groundwater piezometer, designated B-8, was developed/purged and a groundwater sample obtained. Four test pits, designated T-5 thru T-8, were excavated on the Project Site in Area B.

2. The groundwater sample was tested for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and RCRA metals (total and dissolved metals). Analytical testing did not show the presence of VOC or SVOC constituents above the laboratory detection limits. A low concentration of barium was detected in the sample, which in United Consulting's opinion, is consistent with typical naturally occurring groundwater concentrations.

3. Sixteen soil samples were collected for analytical testing of VOCs, SVOCs, total petroleum hydrocarbons (TPH) diesel and gasoline range (DRO/GRO), lead, and/or RCRA metals. Analytical testing did not show VOC or SVOC constituents above the laboratory detection limits in the soil samples collected from Area A. Generally, low concentrations of TPH were detected in some samples in Area B, in the area of a previous underground storage tank (UST). RCRA metals were detected in the samples. The concentrations of lead in six samples and barium and silver in one sample were at concentrations above its Response and Remediation Program (RRP) Notification Concentration (NC). The lead exceedence were in both Areas A and B. The barium and silver exceedence were in Area B.

4. The lead, barium, and silver detections above their NCs require reporting to the RRP within 30 days of the Project Site owner's knowledge of the release. As contracted, United Consulting is in the process of drafting this required notification document.

5. To assist with disposal characterization, TCLP analysis was performed. Those results indicate that, depending on specific landfill requirements, these tested soils should be acceptable for disposal in a Subtitle D landfill.

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1 This Executive Summary is not intended to be used or relied upon without reference to the entire report and cannot otherwise be properly understood and interpreted. It is provided solely for the convenience of the Client and not as a substitute for the report or review of the report.

2 Test pits have been excavated for this assessment, these are designated either "TP" or "T" throughout this report and are interchangeable designations.

PURPOSE

United Consulting was retained by **Atlanta Services Group** to perform a Phase II Environmental Assessment of the Project Site. The purpose of this assessment was to assess for impacts to the soil and groundwater in the area of the planned equalization tank, and to confirm or refute previous data collected in this area. Two potential tank locations were assessed, labeled as Areas A and B, with B being the latest planned location of the tank.

SCOPE OF WORK

The scope of this assessment included the following items as outlined in our July 20, 2012 proposal, which was authorized on via a Task Order (No. 4906004-1) dated July 23, 2012.

1. Advancing five test pits at the Project Site to facilitate the collection of soil samples;

2. Collecting soil samples at various intervals below the existing ground surface from the test pits, and screening the soil samples for organic vapors with a MultiRAE multigas meter;

3. Collecting and submitting two soil samples from each test pit for various analytical testing including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and RCRA metals using EPA testing methods;

4. Collecting and submitting a soil sample for VOCs, SVOC, and RCRA metals analysis via the Toxicity Characteristic Leaching Procedure (TCLP);

5. Collecting and submitting a groundwater sample from an existing piezometer for analytical testing of VOCs, SVOCs, and RCRA metals;

6. Collecting quality control (QC) samples for various laboratory analysis including VOCs, SVOCs, and RCRA metals by EPA methods;

7. Preparing this report to document the results of the subsurface investigation, analytical test results, and to provide United Consulting's professional opinion of the environmental condition of the Project Site.

Due to utilities in the area of one of the planed test pits, only four test pits were conducted.

The above scope was amended to including the following in a revised proposal dated August 10, 2012. This was authorized with via email August 14, 2012.

1. Advancing four test pits at the Project Site to facilitate the collection of soil samples;

2. Collecting soil samples at various intervals below the existing ground surface from the test pits, and screening the soil samples for organic vapors with a MultiRAE multigas meter;

3. Collecting and submitting two soil samples from each test pit for various analytical testing including total petroleum hydrocarbons (TPH) – diesel and gasoline range (TPH-DRO and TPH-GRO), total lead, RCRA metals, and RCRA metals and lead via the Toxicity Characteristic Leaching Procedure (TCLP) using EPA testing methods;

4. Collecting and submitting a composite soil sample for polychlorinated biphynols (PCBs) via the TCLP, and;

5. Collecting quality control (QC) samples for various laboratory analysis including VOCs, PCBs, and RCRA metals by EPA methods.

BACKGROUND

From previously collected geotechnical data by others, there is up to about 15 feet of fill materials in the two areas of the planned equalization tank. Some of these materials had been documented as being black in color with some "coal like" materials. From a previous Phase I Environmental Assessment, there is a former lead smelting facility near the site, the former Metalico-Evans facility. Also, individuals had verbally indicated that the EPA has conducted lead sampling in the community, possibly associated with this facility. The presence of these collective conditions raised concerns relative to the fill in the area of this tank possibly containing elevated concentrations of regulated constituents. Multiple groundwater piezometers were installed as part of previous geotechnical explorations. The purpose of this assessment was to assess for impacts to the soil and groundwater in the areas of the planned equalization tank, and to confirm or refute previous data collected in this area.

INVESTIGATION

Overview

The investigation included advancing four test pits (TP-1 through TP-4) in Area A and four test pits (T-5 through T-8) in Area B on the Project Site. This was to facilitate soil sampling. The test pit locations were identified with Jacobs based on the distribution of previous geotechnical borings in the area. One of the originally planned test pits could not be performed due to the presence of utilities. Existing groundwater piezometer B-8 was developed/purged and sampled.

Soil and groundwater samples were collected for various analytical testing including VOCs, SVOCs, total petroleum hydrocarbons (TPH) – diesel and gasoline range (TPH-DRO and TPH-GRO), and/or RCRA metals. A soil sample was also tested for VOCs, SVOC, and RCRA metals analysis via the TCLP. A composite soil sample, generated from the three soil samples with the highest total lead concentrations, was tested for RCRA metals via the TCLP. One sample was also tested PCBs via the TCLP.

Decontamination was performed and Chain of Custody was maintained, as discussed in the Quality Control section of the report. Sampling at the site was conducted in general accordance with the United States Environmental Protection Agency's (EPA's), current Field Branches Quality System and Technical Procedures (Updated January/February 2008; these procedures are on the internet at EPA's website: http://www.epa.gov/Region4/sesd/fbqstp/).

Test Pits

Test pits TP-1 through TP-4 were excavated on the Project Site on July 25, 2012. Test pits T-5 through T-8 were excavated on the Project Site on August 20, 2012. Prior to excavating T-5 through T-8, the asphalt material were saw cut to minimize disturbance during excavation, and to cut through possible grounding wires for the existing radio tower (coordinated with tower owner during site meeting on August 8). The test pits were excavated using a John Deere 310 backhoe with an approximate maximum excavation extent of 10 feet below the ground surface. The test pits were logged and photographed as the excavations progressed. Following the sampling process, all test pits were backfilled with the excavated materials and subsequently capped with asphalt. These were backfilled in small lifts and packed as possible with the backhoe bucket to grade. Photographs of the conditions encountered in each test pit are included in Appendix C.

Soil Sampling

Soils were observed throughout the excavations. Soil samples were collected from the test pits directly from the backhoe bucket. The soils were inspected and visually classified using the visual-manual procedure. At approximately 2 to 4 foot intervals, the soil samples were screened for organic vapors with a MultiRAE gas meter to ascertain the presence of organic vapors in the soil, as described below. Separate portions of the soil samples were used for organic vapor screening and analytical testing, as required by the EPA.

Area A

Generally, at Area A two grab soil samples were collected from each test pit for analytical testing. At each test pit, one soil sample was from the upper 1 foot to represent surficial samples. These were directly below the existing asphalt and associated base materials, with the actual depths varying based on material thickness and soils consistency for sampling. These surface samples were tested for RCRA metals. A second sample was from deeper depths, which ranged from 2.5 to 6 feet, and tested for VOCs, SVOCs, and RCRA metals. The deeper depth sample was selected based on the field conditions observed (i.e. black soils, "coal like" materials, staining, odors, OVM

response). A third sample was collected from TP-4 from a depth of 6 feet and tested for VOCs, SVOCs, and RCRA metals.

A composite soil sample was generated from black materials encountered in each of the four test pits and tested for RCRA metals via the TCLP. A grab VOC and SVOC sample for TCLP analysis was collected from TP-4 from a depth of 2 feet.

Following the receipt of the totals RCRA metals analytical results, a composite soil sample was generated by the laboratory from the three soil samples with the highest total lead concentrations (TP-1 from 2.5 feet, TP-2 from 1 foot, and TP-2 from 6 feet) and tested for RCRA metals via the TCLP.

Area B

Generally, at Area B two grab soil samples were collected from each test pit for analytical testing. T-5 is reportedly in an area of a previous underground storage tank (UST) that was closed and issued a "no further action" letter by the Environmental Protection Division (EPD). A shallow and deep sample was obtained from this test pit, (depths were based on observed conditions) for analytical testing of TPH-DRO, TPH-GRO, total lead, and lead via the TCLP. A T-6 though T-8, one shallow soil sample was from the upper 2 feet, just below the existing asphalt and associated base materials, and tested for RCRA metals. A second sample was from a deeper depth and also tested for RCRA metals. This deeper depth sample was selected based on the field conditions observed (i.e. black soils, "coal like" materials, staining, odors, OVM response). Following the receipt of the analytical testing results, the sample with the greatest metals concentrations (i.e. the greatest lead concentration) was tested for RCRA metals via the TCLP.

A composite soil sample was generated from fill materials encountered in test pits T-5, T-7, and T-8 (designated C-1) and tested for PCBs metals via the TCLP.

The samples were placed in laboratory-supplied containers, packed on ice, and delivered to an independent analytical laboratory for rush or standard turn around analytical testing. The soil samples for VOC analytical testing were obtained by EPA sampling method 5035A.

Subsurface Conditions

Test pits TP-1, TP-2, and TP-4 were advanced to maximum reach depths of about 8.5 to 10 feet. TP-3 was terminated at a depth of about 8 feet, where rock materials were encountered preventing deeper penetration. T-6 encountered an apparent solid slag mass that did not permit excavation deeper than 1.5 feet (soils were not present here for sampling). Fill materials were encountered throughout the entire excavation depths at the test pits. The fill materials encountered ranged from silts, sands, and clays with varying amounts of slag like materials, organics (including leaves, pine straw, branches, plywood, 2x4's), asphalt like materials, and rock. Groundwater was not encountered within the test pits. A more detailed description of the subsurface conditions encountered is provided on the test pit logs included in Appendix A.

Soil Screening

Select soil samples recovered from the test pits were screened with a MultiRAE to ascertain the presence of organic vapors in the soil. The screening was done by placing each soil sample into a clean plastic bag, sealing it to allow for the collection of organic vapors, and placing the probe of the MultiRAE into the space between the tops of the bags ("headspace"). Measure background conditions at the Project Site were observed to vary at the site from non-detect to about 0.5 ppm. Screening indicated concentrations ranging from 0.4 to 23.4 parts per million (ppm).

At Area A, TP-1 through TP-4, screening indicated concentrations ranging from 0.9 to 11.3 parts per million (ppm). The sample with the greatest OVM result (11.3 ppm) was from TP-1 at a depth of about 10 feet. All other OVM reading varied between 0.9 and 2.4 ppm. These OVM readings are slightly elevated. The soils throughout the test pits had slight odors associated with them. The sample with the greatest OVM reading was comprised of mostly organic materials obtained from the test pit. A soil sample could not be obtained from this depth as there were not sufficient soil materials for sampling.

At Area B, T-5 through T-8, screening indicated concentrations ranging from 0.4 to 23.4 ppm. The test pit with the greatest OVM reading was T-5, where the reported UST was previously located. Petroleum odors were observed in this test pit. The sample with the greatest OVM result (23.4 ppm) was from T-5 at a depth of about 8 feet, where a sample was obtained and tested. The second sample from this test pit was from 2 feet where petroleum odor was evident.

Table 1 summarizes the results of the organic vapor screening. The results are also summarized on the logs in Appendix A.

TABLE 1: SOIL SCREENING RESULTS

	Test Pit Designation							
Depth feet below surface	TP-1	TP-2	TP-3	TP-4	T-5	T-6	T-7	T-8
1	1.5	2.2	2.4		14.9		5.1	0.4
2		2.3		2.4				
3	1.7		2.4					
4				2.2				
5		0.9			5.4		3.1	0.8
6	1.4		1.8	2.2				
8	1.8	1.1	1.2	2.3	23.4		2.9	1.3
10	11.3	0.9		2.1				

Notes:
Results in parts per million (ppm).
Blank cell means not screened.
There were no soils encountered at T-6 for screening.
Background air conditions were non-detect to about 0.5 ppm.

Groundwater Sampling

An existing groundwater piezometer, B-8, was sampled. From review of a geotechnical exploration report, this well was a 2 inch diameter well pipe equipped with a 5 foot section of screen. The well pipe was set at 25 feet. A sand pack was installed around the screen section, which was topped with an 8 inch Bentonite seal. We observed this well to be capped prior to our sampling activities. United Consulting developed/purged this well on July 24, 2012. Through this process, about 25 gallons of groundwater was removed from the well. The developed/purged water was placed in a labeled 55-gallon drum for later appropriate disposal. Following this process, with sufficient groundwater, the well was immediately sampled.

The groundwater sample was obtained using a new, disposable, Teflon lined bailer, connected to new dedicated cord. The groundwater sample were placed in appropriate, clean, laboratory supplied container, packed on ice, and delivered to an independent analytical laboratory for rush analytical testing. The groundwater sample collected was submitted for analytical testing of VOCs, SVOCs, and RCRA metals (total and dissolved metals). The groundwater sample was generally clear at the time of sampling.

QUALITY CONTROL

Procedures

Quality control procedures included cleaning, sampling and Chain-of-Custody maintenance. Additional quality control samples were obtained associated with the sampling and analysis procedures. Chain of Custody of the samples was maintained.

Decontamination

New and dedicated equipment was used for the groundwater sample acquisition.

QC Samples

Various QC samples were used during the sampling and analysis program. This included trip blank samples, three duplicate samples, and two field blank samples. The trip blanks were vials of high performance liquid chromatography (HPLC) water prepared in the laboratory. These samples were transferred with the containers and the soil and/or groundwater samples through the entire trip from the laboratory, to the field, and back to the laboratory. These samples were submitted for VOC analyses. The field blank samples included a SVOC and a PCB container filled with distilled water during the various field sampling processes and tested. The duplicates included a groundwater sample from B-8 for VOC analysis, and RCRA metals soil samples from TP-4 from a depth of about 2.5 feet and from T-7 from a depth of about 8 feet. This was to identify potential external impacts to the soil and/or groundwater samples associated with the laboratory environment and the environment during transport.

Chain-of-Custody

Chain of Custody was used to maintain control of the samples and the associated containers and tests. Chain of custody forms were developed in the laboratory with the sample containers and custody was passed from individual to individual to maintain control of the materials. As the custody of the samples passed from individuals, this was documented on the Chain of Custody forms. Chain-of-Custody was maintained and documented. The chain of custody forms are reproduced in Appendix B.

ANALYTICAL TEST RESULTS

Quality Control Analytical Testing

Three trip blank samples (labeled Trip Blank on laboratory data sheets, one for each analytical report) were used during the drilling, sampling, and sample transportation process for quality

control (QC) assessment. These QC samples were submitted for analytical testing of VOCs by EPA testing method 8260B. No VOC constituents were detected in the trip blank sample.

A duplicate groundwater sample was obtained and tested from B-8 (labeled LD-A on laboratory data sheets) for VOC analysis by EPA testing method 8260B. No VOC constituents were detected in this sample, which was consistent with the other groundwater sample collected at the same time.

A duplicate soil sample was obtained and tested for RCRA metals from TP-4 from a depth of about 2.5 feet (labeled Duplicate on laboratory data sheets) and from T-7 from a depth of about 8 feet (labeled T-7-8A on laboratory data sheets). These were tested by EPA method 6010C. Mercury analysis was by EPA method 7470A. Analytical testing showed the presence of similar concentrations to the original sample from those samples.

The field blank samples included an SVOC container (labeled Field Blank on laboratory data sheets) and a PCB container (labeled B-1 on laboratory data sheets) filled with distilled water during the field sampling processes and tested. SVOC analysis was by EPA method 8270D and PCBs by method 8082A. No SVOC or PCB constituents were detected in the samples.

Based on these results, evidence of potential cross-contamination or laboratory artifacts for the soil/groundwater samples was not present, which provides support for the validity of the analytical testing results for the Project Site. A copy of the laboratory analytical testing data is included in Appendix B.

Soil Analytical Testing

Area A

Two soil samples were collected for each test pit for analytical testing, except at TP-4 where three samples were collected. The near surface sample at each test pit was tested for RCRA metals by EPA method 6010C. Mercury analysis was by EPA method 7470A. The near surface samples at TP-1 through TP-4 were from depths of about 1 foot. The deeper soil samples were tested for VOCs, SVOCs, and RCRA metals using EPA testing methods 8260B, 8270D, and 6010C, respectively. Mercury analysis was via EPA method 7470A. The deeper samples at TP-1 through TP-4 were from depths of about 2.5, 6, 3, and 2.5 feet, respectively. The third sample from TP-4 was from a depth of about 6 feet. There was some apparent matrix interference in some samples at the site, which resulted in elevated detection limits in those samples. See the case narratives with the analytical testing results in Appendix B. The cause for such is unknown.

No VOC or SVOC constituents were detected above the laboratory detection limits in the soil samples collected from the Project Site.

Barium, chromium, and lead were detected in all the samples. Arsenic was detected in one sample, and mercury was detected in two samples. The concentrations of lead in three samples were at concentrations above their respective Response and Remediation Program (RRP)

Notification Concentrations (NCs). This included the concentrations at TP-1 from a depth of about 2.5 feet and from TP-2 from depths of about 1 and 6 feet. No other concentrations were above their NCs. Analytical testing results are summarized in Table 2.

A composite soil sample (labeled TP1 to TP4 on the laboratory data sheets) was generated from black materials encountered in each of the four test pits and tested for RCRA metals via the TCLP. These composite materials were from depths from about 1 to 2 feet, and included the depths with some of the elevated lead detections. This was by EPA methods 6010C/7470A. Barium was detected at a concentration of 0.941 milligrams per liter (mg/L). Following receipt of the initial testing results, a composite soil sample was generated by the laboratory from the three soil samples with the highest total lead concentrations (TP-1 from 2.5 feet, TP-2 from 1 foot, and TP-2 from 6 feet) and tested for RCRA metals via the TCLP. Barium was detected at a concentration of 1.67 mg/L and lead was detected at a concentration of 1.7 mg/L. These are below the RCRA levels for maximum concentration of contaminants for toxicity characteristic of 100 mg/L for barium and 5 mg/L for lead. A grab VOC and SVOC sample for TCLP analysis was collected from TP-4 from a depth of about 2 feet. This was by EPA testing methods 8260B and 8270D, respectively. No VOC or SVOC constituents were detected above the laboratory detection limits.

Area B

Two grab soil samples were collected from each test pit for analytical testing. At T-5 a shallow (about 2 feet) and deep sample (about 8 feet) was obtained for analytical testing of TPH-DRO, TPH-GRO, total lead, and lead via the TCLP. These analyses were by EPA methods 8015C, 8015C, 6010C, and SW1311/6010C, respectively. At T-6 there were no soils for sampling, a solid apparent slag mass was encountered. At T-7 and T-8, one shallow soil sample (about 2 feet) and a deep sample (about 8 feet) was obtained for analytical testing of RCRA metals by EPA method 6010C. Mercury analysis was by EPA method 7471B. Following the receipt of the initial analytical testing results, sample T-8 from about 8 feet, which had the greatest barium, lead, and silver concentrations was tested for RCRA metals via the TCLP. This was by EPA methods SW1311/6010C/7470A. A composite soil sample (designated C-1) was generated from fill materials encountered in each of the three test pits and tested for PCBs metals via the TCLP. This was by EPA method 8082A.

Low concentrations of TPH DRO/GRO and lead were detected in some of the samples from T-5. Barium, chromium, and lead were detected in all the samples from T-7 and T-8. Cadmium, mercury, and silver were detected in three samples. The concentrations of lead in three samples, barium in one sample, and silver in one sample were at concentrations above their respective RRP NCs. This included the concentrations at T-7 from depths of about 2 and 8 feet and from T-8 from a depth of about 8 feet. No other concentrations were above their NCs. Analytical testing results are summarized in Table 2.

Two grab lead samples for TCLP analysis were collected from T-5 from depths of about 2 and 8 feet. Lead was detected in the shallow sample at a concentration of 0.0612 per liter (mg/L), but not in the deeper sample. This lead detection is below the RCRA level for maximum concentration of contaminants for toxicity characteristic of 5 mg/L for lead. Following the receipt of the initial

analytical testing results, sample T-8 from about 8 feet, which had the greatest barium, lead, and silver concentrations was tested for RCRA metals via the TCLP. Barium was detected at a concentration of 1.4 mg/L and lead was detected at a concentration of 0.266 mg/L. These are below the RCRA levels for maximum concentration of contaminants for toxicity characteristic of 100 mg/L for barium and 5 mg/L for lead. A composite soil sample (designated C-1) was generated from fill materials encountered in each of the three test pits and tested for PCBs metals via the TCLP. Leaching concentrations of PCBs were not detected.

A copy of the laboratory analytical test results is included in Appendix B.

TABLE 2: SOIL ANALYTICAL RESULTS SUMMARY

	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Silver	SVOCs	VOCs	TPH-DRO	TPH-GRO
TP-1@1	BRL	75.5	BRL	13.2	154	BRL	BRL	NA	NA	NA	NA
TP-1@2.5	15.9	368	BRL	30.6	**982**	0.231	BRL	BRL[1]	BRL	NA	NA
TP-2@1	BRL	191	BRL	16.8	**455**	BRL	BRL	NA	NA	NA	NA
TP-2@6	BRL	122	BRL	15.5	**466**	0.184	BRL	BRL[1]	BRL	NA	NA
TP-3@1	BRL	105	BRL	36.4	BRL	BRL	BRL	NA	NA	NA	NA
TP-3@3	BRL	93.1	BRL	43.7	BRL	BRL	BRL	BRL	BRL	NA	NA
TP-4@1	BRL	138	BRL	130	101	BRL	BRL	NA	NA	NA	NA
TP-4@2.5	BRL	80.9 (79.0)	BRL	40.2 (47.7)	8.94 (7.47)	BRL	BRL	BRL	BRL	NA	NA
TP-4@6	BRL	85.2	BRL	43.1	8.33	BRL	BRL	BRL	BRL	NA	NA
T-5@2	NA	NA	BRL	NA	24.9	NA	BRL	NA	NA	22	1.1
T-5@8	NA	NA	BRL	NA	17.1	NA	BRL	NA	NA	BRL	1.1
T-7@2	BRL	198	BRL	43.3	**735**	0.166	4.13	NA	NA	NA	NA
T-7@8	BRL (BRL)	433 (362)	18 (20.4)	44 (38.9)	**1630 (1730)**	0.801 (1.22)	7.08 (7.95)	NA	NA	NA	NA
T-8@2	BRL	191	2.9	25.4	239	BRL	BRL	NA	NA	NA	NA
T-8@8	BRL	**771**	5.38	47.1	**2040**	4.31	**11.4**	NA	NA	NA	NA
NC	41	500/BG	39	1200	400	17	10/BG	Various	Various	--	--

Notes:
1: Due to apparent matrix interference, sample dilution was required resulting in elevated SVOC detection limits.
Concentrations in (#) are duplicate sample results.
NA is not analyzed.
BRL is below laboratory reporting limit.
-- is not applicable
All results in mg/Kg: milligrams per kilogram.
Bold results indicate concentration above the Response and Remediation Program Notification Concentration (NC); BG means the listed NC or background conditions.

TABLE 3: TCLP ANALYTICAL RESULTS SUMMARY

	Composite /Grab Sample	Barium	Lead	SVOCs	VOCs	PCBs
TP-1 to TP-4	C	0.941	BRL	NA	NA	NA
TP-1@2.5/ TP-2@1/ TP-2@6	C	1.67	1.7	NA	NA	NA
TP-4@2	G	NA	NA	BRL	BRL	NA
T-5@2	G	NA	0.0612	NA	NA	NA
T-5@8	G	NA	BRL	NA	NA	NA
T-8@8	G	1.4	0.266	NA	NA	NA
C-1	C	NA	NA	NA	NA	BRL
MTC		100	5	Various	Various	Various

Notes:
NA is not analyzed.
BRL is below laboratory reporting limit.
All results in mg/L: milligrams per liter.
RCRA metals listed were BRL. Sample from T-5 were only tested for lead.
MTC is Maximum Concentration of Contaminants for the Toxicity Characteristic from CFR Title 40, Volume 24, Part 261, Section 24

Groundwater Analytical Testing

A groundwater sample was obtained from piezometer B-8 (labeled LD-B8 on laboratory data sheets) for analytical testing of VOCs, SVOCs, and RCRA metals using EPA testing methods 8260B, 8270D, and 6010C, respectively. Mercury analysis was via EPA method 7470A.

Analytical testing did not show the presence of VOC or SVOC constituents above the laboratory detection limits.

Due to the turbidity of the groundwater samples (they were slightly turbid); the samples for RCRA metals analysis were tested for both total and dissolved (or filtered) RCRA metals. The metal barium was detected in both the total and dissolved tests. No other RCRA metals were detected. The total and dissolved barium concentrations were 0.043 and 0.0347 milligrams per liter (mg/L), respectively. These concentrations are below its Federal drinking water Maximum Contaminant Level of 2 mg/L.

A copy of the laboratory analytical test results is included in Appendix B.

DATA EVALUATION AND ENVIRONMENTAL ASSESSMENT

From previously collected geotechnical data by others, there is up to about 15 feet of fill materials in the two areas of the planned equalization tank. The fill reportedly varied in consistency, but appeared to obtain "coal like" materials. There were concerns that these materials may be slag or associated materials from a nearby former smelting facility, the former Metalico-Evans facility. We were told that others conducted limited soil and groundwater testing in Area A of this Phase II, which resulted in questionable results. We were not provided with the previous data.

For this assessment, an existing piezometer, B-8, was developed/purged and sampled for VOCs, SVOCs, and RCRA metals (total and dissolved metals). Analytical testing did not show the presence of VOC or SVOC constituents above the laboratory detection limits. A release of VOCs or SVOCs in groundwater has not been detected. Barium was detected in both the total and dissolved tests, at low concentrations. These were below its Federal drinking water Maximum Contaminant Level of 2 mg/L. In United Consulting's opinion, the barium concentrations detected was consistent a typical naturally occurring groundwater concentration for this geographical region and not indicative of a release.

The investigation included advancing four test pits (TP-1 through TP-4) in Area A and four test pits (T-5 through T-8) in Area B. The test pits extended to depths up to about 10 feet. Fill materials of varying consistencies were encountered throughout each test pit, generally including highly organic materials (e.g. decomposed pine straw, wood, etc.). There were black "ash like" materials at TP-1 and TP-2, and "slag like" materials in the upper 2 feet at TP-4. T-5 was located in the area of a previously removed UST. At T-6 there was a solid apparent slag mass

encountered at about 1.5 feet. In Area A, organic vapor screening showed very low concentrations, mostly in the 1 to 2 ppm range. One screened sample had a concentration of 11.3 ppm. This was in an area with a significant amount of organics. There was not sufficient soil at this depth for actual soil sampling. The elevated OVM readings could have been the results of the extensive organic materials. In Area B, screening indicated concentrations ranging from 0.4 to 23.4 ppm. The test pit with the greatest OVM reading was T-5, where the reported UST was previously located. Soils representative of the sample with the greatest OVM result (23.4 ppm) were obtained and tested.

From the eight test pits 16 soil samples were collected for analytical testing of VOCs, SVOCs, RCRA metals, lead, TPH-DRO, and/or TPH-GRO. Two samples were from each test pit, except at TP-4 where a third sample was obtained and tested. Soils were not encountered at T-6 for sampling prior to refusal. One soil sample was from the upper 1 to 2 feet to represent surficial samples. The deeper samples were selected based on the field conditions observed with an attempt to select worst case materials (i.e. black soils, "coal like" materials, staining, odors, OVM response[3]). Analytical testing did not show VOC or SVOC constituents above the laboratory detection limits in the soil samples collected from the Project Site. Generally low concentrations of TPH-DRO and TPH-GRO were detected in some of the samples from T-5, where a UST was previously present. United Consulting understands this UST was properly closed in accordance with the UST regulations. We did not perform a review of such documents.

Some RCRA metals were detected in the soil samples. The concentrations of lead in six samples were at concentrations above its RRP NC. This included samples from both Area A and B. This included the concentrations at TP-1 from a depth of about 2.5 feet, from TP-2 from depths of about 1 and 6 feet, from T-7 from depths of about 2 and 8 feet, and from T-8 at 8 from a depth of about 8 feet. In area A, the black "ash like" materials had the greatest lead detections. The concentrations of barium and silver in one sample from Area B were at concentrations above their RRP NCs. This included the concentrations at T-8 from a depth of about 8 feet. No other concentrations were above their NCs. The lead, barium, and silver detections above their NCs require reporting to the RRP within 30 days of the Project Site owner's knowledge of the release. To assist with disposal characterization, multiple samples were obtained from Areas A and B and tested for various analytical suites via the TCLP. This included samples for VOCs, SVOCs, RCRA metals, lead, and PCBs. Three samples were for RCRA metals TCLP analysis and included a composite sample generated in the field from materials from each of the four test pits TP-1 to TP-4, a composite sample generated in the lab from the three soil samples with the highest total lead concentrations at Area A (from TP-1 and TP-2), and a grab sample that had the greatest barium, lead, and silver concentrations (from T-8 from about 8 feet). Two samples were for lead TCLP analysis and were grab samples from T-5. One sample was for VOC and SVOC TCLP analysis and was a grab sample from TP-2. One sample was for PCB TCLP analysis and was a composite sample generated in the field from materials in test pits T-5, T-7, and T-8. Analysis indicated leaching concentrations of barium and lead only. The concentrations detected were below the RCRA level for maximum concentration of contaminants for toxicity characteristic. Based on

3 A sufficient soil volume was not present at the soil sample with the greatest OVM response for analytical testing (TP-3 at 10 feet).

the results, depending on specific landfill requirements, these tested soils should be acceptable for disposal in a Subtitle D landfill.

CONCLUSIONS

Based on the analysis performed, groundwater impacts indicative of a release have not been detected. Lead concentrations in six soil samples and barium and silver in one soil sample were above their NCs, and therefore require reporting to the RRP within 30 days of the Project Site owner's knowledge of the release. The EPD's RRP notification and evaluation process includes the following steps:

- Reporting of the release on the prescribed forms;
- Evaluation of the potential magnitude of the release;
- Identification of potential receptors;
- Calculation of the risk using the Reportable Quantity Screening Method (RQSM); and
- Determination of the site's status for potential listing and/or remediation.

After the RRP receives their required release notification, the information provided will guide the RRP in determining whether the Project Site will be listed on the Hazardous Site Inventory (HSI). Their determination is dependent upon many factors, which are presented in the release notification document. As contracted, United Consulting is in the process of drafting this required notification document.

To assist with disposal characterization, TCLP analysis was performed. Those results indicate that, depending on specific landfill requirements, these tested soils should be acceptable for disposal in a Subtitle D landfill.

LIMITATIONS

United Consulting has performed appropriate inquiry for this Phase II Environmental Assessment. The analysis and evaluation presented in this report are based on the results of this investigation. Contamination levels should be expected to vary from the boring locations and with time. In addition, regulatory criteria for reporting and/or remediation have changed over time, and will likely be different in the future.

United Consulting's conclusions, opinions and suggestions have been prepared using generally accepted standards prevailing within the relevant disciplines as practiced within the southeastern United States. The data analysis and recommendations stated herein are professional opinions; no warranty is expressed or implied. United Consulting is not responsible for the conclusions, opinions or recommendations of others. Nothing contained within this report is intended to supersede or replace the judgment of the Client. All decisions relating to the aforementioned project or site are the sole responsibility of said users.

This Phase II Environmental Assessment has been prepared for the named client. Should any other person, partnership, or corporation desire to rely upon this report, it will be necessary for United Consulting to update it for the new user. The right to rely upon this report and the data herein may not be assigned without the express written permission of United Consulting. As a prerequisite for the granting of, such permission, the third-party users, (including, but not limited to, the Client's successors and assigns) must agree to be bound by the terms and conditions of the original agreement between United Consulting and the Client. Further, reliance is dependent on similar uses of the property and the document.

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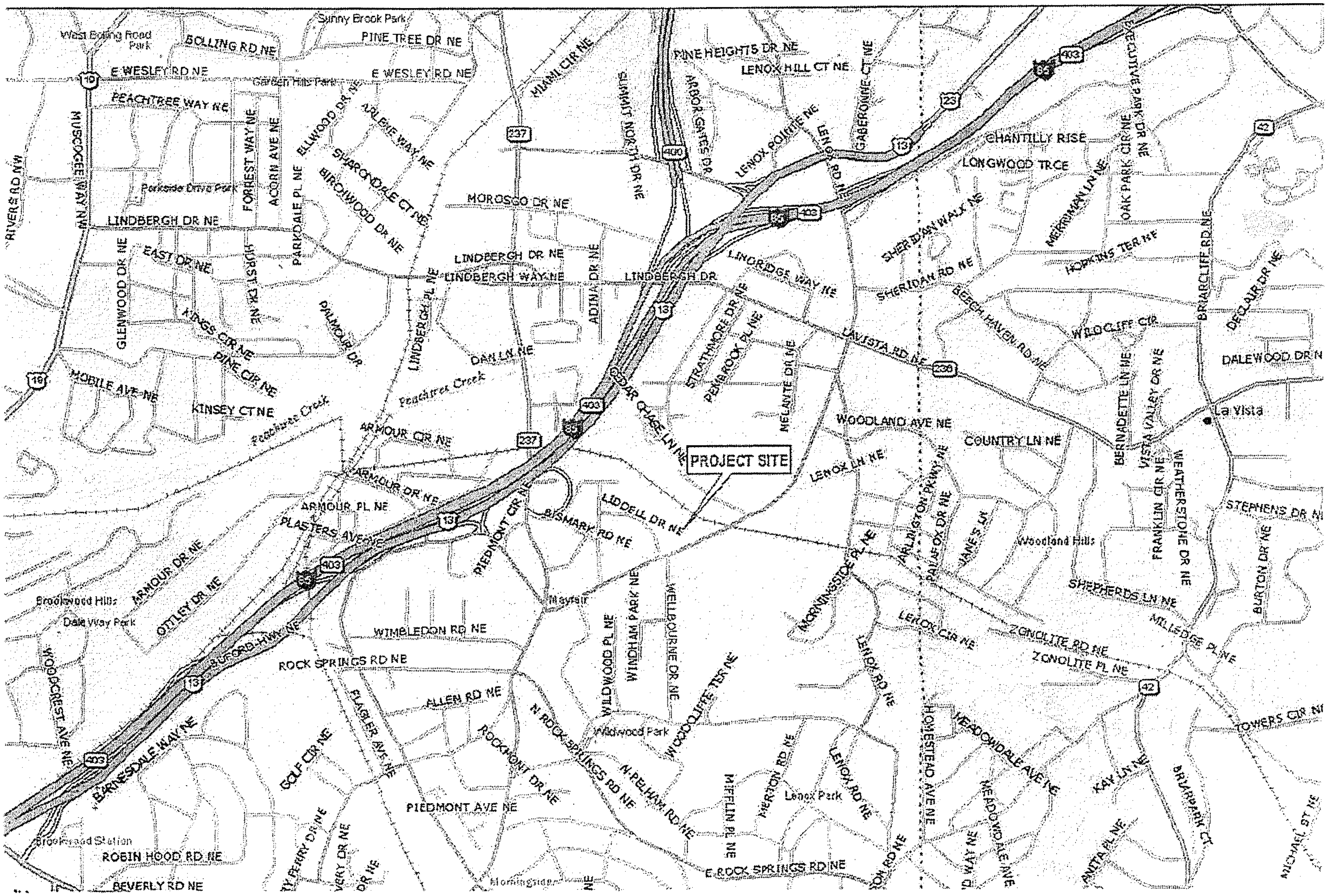
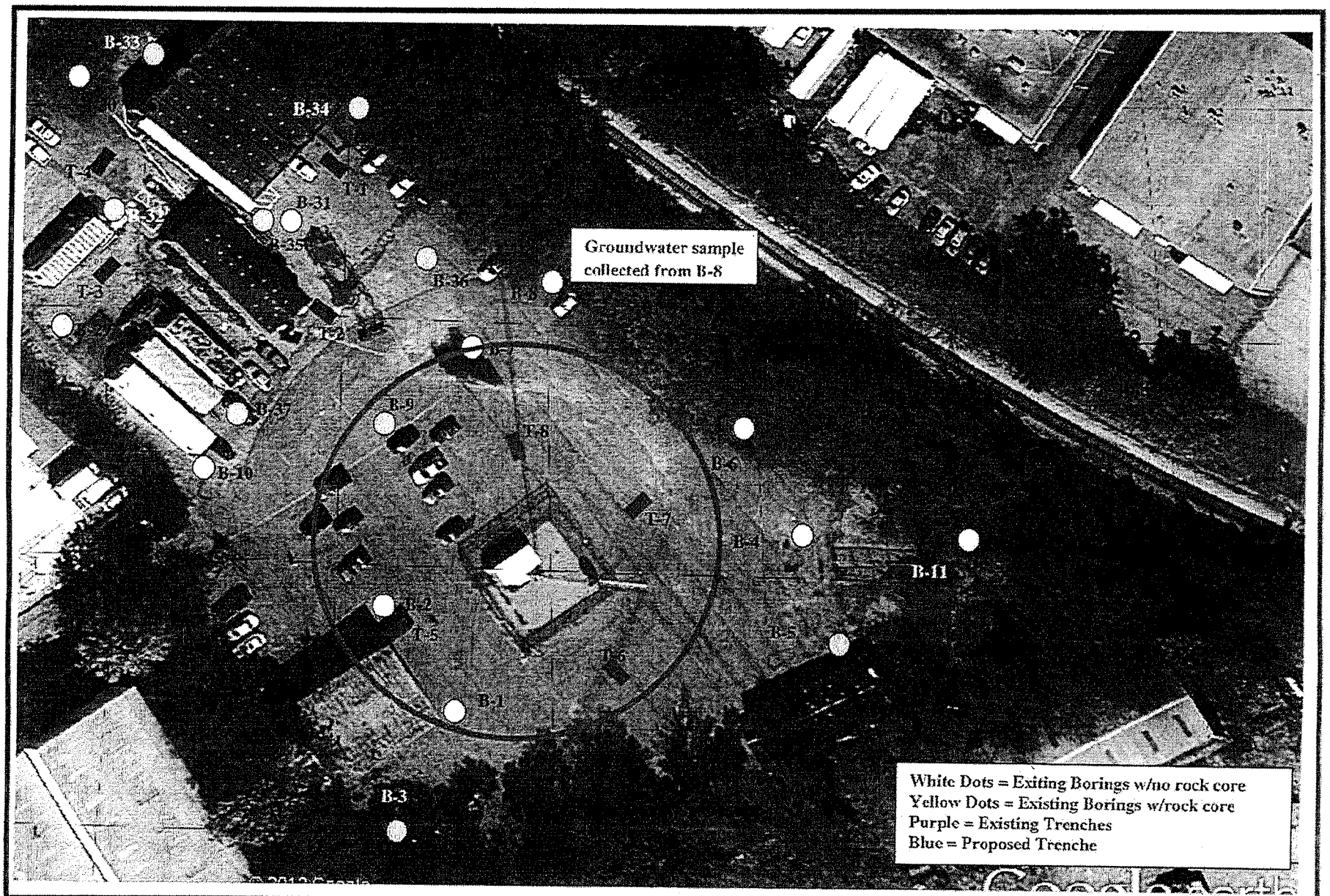


UNITED CONSULTING — *We're here for you*	N	Scale:	≈ 1" = 2,000'	Notes:	Client: Jacobs
		Prepared:	SHH		Site: Liddell Drive Equalization Project
		Checked:			
		Project No.:	2012.3532.01		Title: Site Location Plan

FIG. 1



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N

Scale:	Not to Scale
Prepared:	SHH
Checked:	
Project No.:	2012.3532.01

Notes:

Client:	Jacobs
Site:	Liddell Drive Equalization Project
Title:	Test Pit/GW Sampling Plan

FIG. 2

APPENDIX A – BORING LOGS

UNITED CONSULTING
625 HOLCOMB BRIDGE ROAD
NORCROSS, GEORGIA 30071
(770)209-0029, FAX (770)582-2800

LOG OF TEST PIT

CONTRACTED WITH: Jacobs TEST PIT NO.: TP-1

PROJECT NAME: Liddell Dive Equalization Project JOB NO.: 2012.3532.01 DATE: 7/25/12

ELEV.	DESCRIPTION	DEPTH in FEET	NOTES
	8" asphalt	0	
	black ash like material,some sand and silt (fill)		ovm=1.5
	large amounts of organic debris (pinestraw, leaves, wood) with small of amounts of sand and silt;black (fill)		ovm=1.7
		5	
			ovm=1.4
			ovm=1.8
		10	
	Test Pit Terminated		ovm=11.3
		15	
		20	
		25	
		30	
		35	
		40	

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LOG OF TEST PIT

CONTRACTED WITH: Jacobs TEST PIT NO.: TP-2

PROJECT NAME: Liddell Dive Equalization Project JOB NO.: 2012.3532.01 DATE: 7/25/12

ELEV.	DESCRIPTION	DEPTH in FEET	NOTES
	8" asphalt	0	
	black ash like material,some sand and silt (fill)		ovm=2.2
			ovm=2.3
	large amounts of organic debris (pinestraw, leaves, wood) with some of amounts of sand and silt;black (fill)	5	
	;some asphalt like material		ovm=0.9
			ovm=1.1
	Test Pit Terminated	10	ovm=0.9
		15	
		20	
		25	
		30	
		35	
		40	

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LOG OF TEST PIT

CONTRACTED WITH: Jacobs TEST PIT NO.: TP-3

PROJECT NAME: Liddell Dive Equalization Project JOB NO.: 2012.3532.01 DATE: 7/25/12

ELEV.	DESCRIPTION	DEPTH in FEET	NOTES
	12" GAB	0	
	Silt, some sands: orange (fill)		ovm=2.4
			ovm=2.4
		5	
			ovm=1.8
	Test Pit Terminated		ovm=1.2
		10	
		15	
		20	
		25	
		30	
		35	
		40	

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LOG OF TEST PIT

CONTRACTED WITH: Jacobs TEST PIT NO.: TP-4

PROJECT NAME: Liddell Dive Equalization Project JOB NO.: 2012.3532.01 DATE: 7/25/12

ELEV.	DESCRIPTION	DEPTH in FEET	NOTES
	8" Asphalt	0	
	slag like material; grey (fill)		ovm=2.4
	silt, some sand, trace clay; grey/brown (fill)	5	ovm=2.2
			ovm=2.2
			ovm=2.3
	Test Pit Terminated	10	ovm=2.1
		15	
		20	
		25	
		30	
		35	
		40	

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LOG OF TEST PIT

CONTRACTED WITH: JACOBS TEST PIT NO.: T-5

PROJECT NAME: LIDDELL DRIVE EQUALIZATION PROJECT JOB NO.: 2012.3532.01 DATE: 8/20/12

ELEV.	DESCRIPTION	DEPTH In FEET	NOTES
	ASPHALT		
	SAND, SOME CLAY, TRACE SILT, MICA, RED (FILL)		OVM = 14.9 PPM
		2	
	SAND, SOME SILT, TRACE CLAY, MICA; BROWN (FILL)		PETRO ODOR
		4	
			OVM = 5.4 PPM
		6	
		8	OVM = 23.4 PPM
	TEST PIT TERMINATED AT 8.5'		
		10	
		12	
		14	
		16	

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LOG OF TEST PIT

CONTRACTED WITH: JACOBS TEST PIT NO.: T-6

PROJECT NAME: LIDDELL DRIVE EQUALIZATION PROJECT JOB NO.: 2012.3532.01 DATE: 8/20/12

ELEV.	DESCRIPTION	DEPTH in FEET	NOTES
	ASPHALT		
	SLAG		
	REFUSAL AT 1.5'	2	
		4	
		6	
		8	
		10	
		12	
		14	
		16	

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LOG OF TEST PIT

CONTRACTED WITH: JACOBS TEST PIT NO.: T-7

PROJECT NAME: LIDDELL DRIVE EQUALIZATION PROJECT JOB NO.: 2012.3532.01 DATE: 8/20/12

ELEV.	DESCRIPTION	DEPTH in FEET	NOTES
	8" ASPHALT		
	SAND, SOME SILT, ORGANICS, MICA, DEBRIS, BLACK (FILL)		OVM = 5.1 PPM
	ORGANICS (TREE LIMBS/PINE STRAW) SAND, SOME SILT, DEBRIS; BLACK	2	85% ORGANICS WITH SOME INORGANIC DEBRIS
		4	
		6	OVM = 3.1 PPM
		8	OVM = 2.9 PPM
	TEST PIT TERMINATED AT 9'	10	
		12	
		14	
		16	

UNITED CONSULTING
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NORCROSS, GEORGIA 30071
(770)209-0029, FAX (770)582-2800

LOG OF TEST PIT

CONTRACTED WITH: JACOBS TEST PIT NO.: T-8

PROJECT NAME: LIDDELL DRIVE EQUALIZATION PROJECT JOB NO.: 2012.3532.01 DATE: 8/20/12

ELEV.	DESCRIPTION	DEPTH in FEET	NOTES
	18" ASPHALT		
	SAND, SOME SILT, ORGANICS, MICA, DEBRIS, BLACK (FILL)	2	OVM = 0.4 PPM
	ORGANICS (TREE LIMBS/PINE STRAW.2X4s) SAND, SOME SILT, DEBRIS; BLACK		85% ORGANICS WITH SOME INORGANIC DEBRIS
		4	
		6	OVM = 0.8 PPM DEBRIS INCLUDED PLASTICS AND METALS
		8	OVM = 1.3 PPM
	TEST PIT TERMINATED AT 9'	10	
		12	
		14	
		16	

APPENDIX B – CHAIN OF CUSTODY/LABORATORY ANALYTICAL TESTING DATA

AES

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

August 30, 2012

Seth Hobson
United Consulting Group Inc.
625 Holcomb Bridge Rd
Norcross GA 30071

TEL: (770) 582-2788
FAX: (770) 582-2900

RE: Liddell Drive

Dear Seth Hobson: Order No: 1208F48

Analytical Environmental Services, Inc. received 10 samples on August 20, 2012 2:30 pm for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the analyses contained herein will be noted and submitted in the form of a project Case Narrative.
AES' certifications are as follows:
-NELAC/Florida Certification number E87582 for analysis of Environmental Water, soil/hazardous waste, and Drinking Water Microbiology, effective 07/01/12-06/30/13.
-AIHA Certification ID #100671 for Industrial Hygiene samples (Organics, Inorganics), Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) effective until 09/01/13.

These results relate only to the items tested. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Kathryn E. Waters

Kathryn Waters
Project Manager

ANALYTICAL ENVIRONMENTAL SERVICES, INC
3785 Presidential Parkway, Atlanta GA 30340-3704
AES TEL.: (770) 457-8177 / TOLL-FREE (800) 972-4889 / FAX: (770) 457-8188

CHAIN OF CUSTODY

Work Order: 1208F48

Date: 8-20-12 Page 1 of 1

COMPANY: United Consulting
ADDRESS: 625 Holcomb Bridge Rd Norcross, GA
PHONE:
FAX:
SAMPLED BY: Seth Hall
SIGNATURE:

#	SAMPLE ID	SAMPLED DATE	SAMPLED TIME	Grab	Composite	Matrix (See codes)	TPH-GRO	TPH-DRO	Total Pb	Pb TCLP	PCBs	PCBs - TCLP	VOCs	REMARKS	No # of Containers
	PRESERVATION (See codes)						H+I	H+I	H+I	H+I	H+I				
1	T-5-2'	8-20	11:15	X		SO	X	X	X	X	X				
2	T-5-8'		11:35	X		SO	X	X	X	X	X				
3	T-7-2'		1:10	X		SO					X				
4	T-7-8'		1:25	X		SO					X				
5	T-7-8A		1:25	X		SO					X				
6	T-8-2'		10:25	X		SO					X				
7	T-8-8'		10:35	X		SO					X				
8	B-1		1:40	X		W						X			
9	C-1		1:40		X	SO							X		
10	Trip Blank					W							X		
11															
12															
13															
14															

Visit our website www.aesatlanta.com to check on the status of your results, place bottle orders, etc.

RELINQUISHED BY: 1. DATE/TIME: 8-20-12 2:30
RECEIVED BY: 1. DATE/TIME: 8/20/12 2:30
2.
3.

PROJECT INFORMATION
PROJECT NAME: Liddell DC
PROJECT #: 2012 3532 01
SITE ADDRESS:
SEND REPORT TO:
INVOICE TO: (IF DIFFERENT FROM ABOVE)
QUOTE #: PO#:

RECEIPT
Total # of Containers:

Turnaround Time Request
- (●) Standard 5 Business Days
- ( ) 2 Business Day Rush
- ( ) Next Business Day Rush
- ( ) Same Day Rush (auth req.)
- ( ) Other

STATE PROGRAM (if any):
E-mail? Y / N, Fax? Y / N
DATA PACKAGE: I II III IV

SPECIAL INSTRUCTIONS/COMMENTS:

SHIPMENT METHOD
OUT / /
IN / /
VIA:
CLIENT FedEx UPS MAIL COURIER
GREYHOUND OTHER

SAMPLES RECEIVED AFTER 3PM OR ON SATURDAY ARE CONSIDERED RECEIVED THE NEXT BUSINESS DAY. IF TURNAROUND TIME IS NOT INDICATED, AES WILL PROCEED WITH STANDARD TAT OF SAMPLES.
SAMPLES ARE DISPOSED 30 DAYS AFTER REPORT COMPLETION UNLESS OTHER ARRANGEMENTS ARE MADE.

MATRIX CODES: A = Air GW = Groundwater SE = Sediment SO = Soil SW = Surface Water W = Water (Blanks) DW = Drinking Water (Blanks) O = Other (specify) WW = Waste Water
PRESERVATIVE CODES H+I = Hydrochloric acid + ice I = Ice only N = Nitric acid S+I = Sulfuric acid + ice S/M+I = Sodium Bisulfate/Methanol + ice O = Other (specify) NA = None

White Copy - Original; Yellow Copy - Client

Analytical Environmental Services, Inc

Date: 30-Aug-12

Client: United Consulting Group Inc.
Project: Liddell Drive
Lab ID: 1208F48

Case Narrative

Sample Receiving Nonconformance:

Sample information on the Chain of Custody did not match that on the sample bottle labels for samples -001, -006, and -007. Samples were logged in using the information on the CoC. They were matched according to the collection date/time. Sample IDs were left blank on samples -001 and -007. Sample -006 was labeled "T-8".

Volatiles Organic Compounds Analysis by Method 8260B:

QC samples 1208E51-021AMS/MSD were extracted and/or analyzed outside holding time of 14 days. Analysis was requested by client after holding time had expired.

Metals Analysis by Method 6010B:

Due to sample matrix, samples 1208F48-003A thru -007A required dilution during analysis resulting in elevated reporting limits.

TCLP Metals was requested on sample T-8-8' (1208F48-007A) with next day results per phone instructions from Seht Hobson on 8/28/12 at 11:47am.

Per phone instructions from the Seth Hobson on 8/28/12 at 5:12 pm the trip blank should be analyzed for VOC.

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	T-5-2'
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 11:15:00 AM
Lab ID:	1208F48-001	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
ICP METALS, TCLP SW1311/6010C				**(SW3010A)**				
Lead	0.0612	0.0500		mg/L	165456	1	08/23/2012 15:52	TA
GASOLINE RANGE ORGANICS SW8015C				**(SW5035)**				
TPH (Gasoline Range Organics)	1.1	0.39		mg/Kg-dry	165528	1	08/23/2012 17:08	JE
Surr: a,a,a-trifluorotoluene	95.5	65.2-152		%REC	165528	1	08/23/2012 17:08	JE
DIESEL RANGE ORGANICS SW8015C				**(SW3550C)**				
TPH (Diesel Range Organics)	22	7.8		mg/Kg-dry	165531	1	08/23/2012 21:18	SH
Surr: Dioctylphthalate	93.6	47.4-128		%REC	165531	1	08/23/2012 21:18	SH
METALS, TOTAL SW6010C				**(SW3050B)**				
Lead	24.9	5.52		mg/Kg-dry	165458	1	08/23/2012 17:20	MR
PERCENT MOISTURE D2216								
Percent Moisture	14.4	0		wt%	R227703	1	08/24/2012 11:30	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	T-5-8'
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 11:35:00 AM
Lab ID:	1208F48-002	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
ICP METALS, TCLP SW1311/6010C				**(SW3010A)**				
Lead	BRL	0.0500		mg/L	165456	1	08/23/2012 15:56	TA
GASOLINE RANGE ORGANICS SW8015C				**(SW5035)**				
TPH (Gasoline Range Organics)	1.1	0.51		mg/Kg-dry	165528	1	08/23/2012 17:36	JE
Surr: a,a,a-trifluorotoluene	91.9	65.2-152		%REC	165528	1	08/23/2012 17:36	JE
DIESEL RANGE ORGANICS SW8015C				**(SW3550C)**				
TPH (Diesel Range Organics)	BRL	9.7		mg/Kg-dry	165531	1	08/23/2012 20:55	SH
Surr: Dioctylphthalate	88.2	47.4-128		%REC	165531	1	08/23/2012 20:55	SH
METALS, TOTAL SW6010C				**(SW3050B)**				
Lead	17.1	6.82		mg/Kg-dry	165458	1	08/23/2012 17:23	MR
PERCENT MOISTURE D2216								
Percent Moisture	30.7	0		wt%	R227703	1	08/24/2012 11:30	AS

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	T-7-2'
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 1:10:00 PM
Lab ID:	1208F48-003	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B				**(SW7471B)**				
Mercury	0.166	0.117		mg/Kg-dry	165447	1	08/22/2012 13:53	LD
METALS, TOTAL SW6010C				**(SW3050B)**				
Arsenic	BRL	11.7		mg/Kg-dry	165458	2	08/24/2012 12:37	MR
Barium	198	5.87		mg/Kg-dry	165458	1	08/23/2012 16:54	MR
Cadmium	BRL	2.94		mg/Kg-dry	165458	1	08/23/2012 16:54	MR
Chromium	43.3	2.94		mg/Kg-dry	165458	1	08/23/2012 16:54	MR
Lead	735	5.87		mg/Kg-dry	165458	1	08/23/2012 16:54	MR
Selenium	BRL	11.7		mg/Kg-dry	165458	2	08/24/2012 12:37	MR
Silver	4.13	2.94		mg/Kg-dry	165458	1	08/23/2012 16:54	MR
PERCENT MOISTURE D2216								
Percent Moisture	15.3	0		wt%	R227703	1	08/24/2012 11:30	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	T-7-8'
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 1:25:00 PM
Lab ID:	1208F48-004	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					(SW7471B)			
Mercury	0.801	0.143		mg/Kg-dry	165447	1	08/22/2012 13:56	LD
METALS, TOTAL SW6010C					(SW3050B)			
Arsenic	BRL	14.1		mg/Kg-dry	165458	2	08/24/2012 12:41	MR
Barium	433	7.04		mg/Kg-dry	165458	1	08/23/2012 17:26	MR
Cadmium	18.0	3.52		mg/Kg-dry	165458	1	08/23/2012 17:26	MR
Chromium	44.0	3.52		mg/Kg-dry	165458	1	08/23/2012 17:26	MR
Lead	1630	7.04		mg/Kg-dry	165458	1	08/23/2012 17:26	MR
Selenium	BRL	14.1		mg/Kg-dry	165458	2	08/24/2012 12:41	MR
Silver	7.08	3.52		mg/Kg-dry	165458	1	08/23/2012 17:26	MR
PERCENT MOISTURE D2216								
Percent Moisture	30.8	0		wt%	R227703	1	08/24/2012 11:30	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	T-7-8A
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 1:25:00 PM
Lab ID:	1208F48-005	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					(SW7471B)			
Mercury	1.22	0.138		mg/Kg-dry	165447	1	08/22/2012 13:58	LD
METALS, TOTAL SW6010C					(SW3050B)			
Arsenic	BRL	6.79		mg/Kg-dry	165458	1	08/23/2012 17:29	MR
Barium	362	6.79		mg/Kg-dry	165458	1	08/23/2012 17:29	MR
Cadmium	20.4	3.40		mg/Kg-dry	165458	1	08/23/2012 17:29	MR
Chromium	38.9	3.40		mg/Kg-dry	165458	1	08/23/2012 17:29	MR
Lead	1730	6.79		mg/Kg-dry	165458	1	08/23/2012 17:29	MR
Selenium	BRL	13.6		mg/Kg-dry	165458	2	08/24/2012 12:44	MR
Silver	7.95	3.40		mg/Kg-dry	165458	1	08/23/2012 17:29	MR
PERCENT MOISTURE D2216								
Percent Moisture	28.6	0		wt%	R227703	1	08/24/2012 11:30	AS

Qualifiers:

* Value exceeds maximum contaminant level	E Estimated (value above quantitation range)
BRL Below reporting limit	S Spike Recovery outside limits due to matrix
H Holding times for preparation or analysis exceeded	Narr See case narrative
N Analyte not NELAC certified	NC Not confirmed
B Analyte detected in the associated method blank	< Less than Result value
> Greater than Result value	J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	T-8-2'
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 10:25:00 AM
Lab ID:	1208F48-006	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					(SW7471B)			
Mercury	BRL	0.113		mg/Kg-dry	165447	1	08/22/2012 14:05	LD
METALS, TOTAL SW6010C					(SW3050B)			
Arsenic	BRL	5.20		mg/Kg-dry	165458	1	08/23/2012 17:32	MR
Barium	191	5.20		mg/Kg-dry	165458	1	08/23/2012 17:32	MR
Cadmium	2.90	2.60		mg/Kg-dry	165458	1	08/23/2012 17:32	MR
Chromium	25.4	2.60		mg/Kg-dry	165458	1	08/23/2012 17:32	MR
Lead	239	5.20		mg/Kg-dry	165458	1	08/23/2012 17:32	MR
Selenium	BRL	10.4		mg/Kg-dry	165458	2	08/24/2012 12:47	MR
Silver	BRL	2.60		mg/Kg-dry	165458	1	08/23/2012 17:32	MR
PERCENT MOISTURE D2216								
Percent Moisture	12.1	0		wt%	R227703	1	08/24/2012 11:30	AS

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	T-8-8'
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 10:35:00 AM
Lab ID:	1208F48-007	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B				**(SW7471B)**				
Mercury	4.31	1.47		mg/Kg-dry	165447	10	08/22/2012 15:15	LD
MERCURY, TCLP SW1311/7470A				**(SW7470A)**				
Mercury	BRL	0.00400		mg/L	165764	1	08/29/2012 13:37	LD
ICP METALS, TCLP SW1311/6010C				**(SW3010A)**				
Arsenic	BRL	0.250		mg/L	165769	1	08/29/2012 13:36	MR
Barium	1.40	0.500		mg/L	165769	1	08/29/2012 13:36	MR
Cadmium	BRL	0.0250		mg/L	165769	1	08/29/2012 13:36	MR
Chromium	BRL	0.0500		mg/L	165769	1	08/29/2012 13:36	MR
Lead	0.266	0.0500		mg/L	165769	1	08/29/2012 13:36	MR
Selenium	BRL	0.100		mg/L	165769	1	08/29/2012 13:36	MR
Silver	BRL	0.0250		mg/L	165769	1	08/29/2012 13:36	MR
METALS, TOTAL SW6010C				**(SW3050B)**				
Arsenic	BRL	34.0		mg/Kg-dry	165458	5	08/24/2012 13:27	MR
Barium	771	6.81		mg/Kg-dry	165458	1	08/23/2012 17:35	MR
Cadmium	5.38	3.40		mg/Kg-dry	165458	1	08/23/2012 17:35	MR
Chromium	47.1	3.40		mg/Kg-dry	165458	1	08/23/2012 17:35	MR
Lead	2040	6.81		mg/Kg-dry	165458	1	08/23/2012 17:35	MR
Selenium	BRL	13.6		mg/Kg-dry	165458	2	08/24/2012 13:15	MR
Silver	11.4	3.40		mg/Kg-dry	165458	1	08/23/2012 17:35	MR
PERCENT MOISTURE D2216								
Percent Moisture	31.9	0		wt%	R227703	1	08/24/2012 11:30	AS

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	B-1
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 1:40:00 PM
Lab ID:	1208F48-008	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
POLYCHLORINATED BIPHENYLS	**SW8082A**				**(SW3510C)**			
Aroclor 1016	BRL	0.50		ug/L	165583	1	08/27/2012 16:52	SN
Aroclor 1221	BRL	0.50		ug/L	165583	1	08/27/2012 16:52	SN
Aroclor 1232	BRL	0.50		ug/L	165583	1	08/27/2012 16:52	SN
Aroclor 1242	BRL	0.50		ug/L	165583	1	08/27/2012 16:52	SN
Aroclor 1248	BRL	0.50		ug/L	165583	1	08/27/2012 16:52	SN
Aroclor 1254	BRL	0.50		ug/L	165583	1	08/27/2012 16:52	SN
Aroclor 1260	BRL	0.50		ug/L	165583	1	08/27/2012 16:52	SN
Surr: Decachlorobiphenyl	72.1	15.5-128		%REC	165583	1	08/27/2012 16:52	SN
Surr: Tetrachloro-m-xylene	90	17.3-125		%REC	165583	1	08/27/2012 16:52	SN

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	C-1
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012 1:40:00 PM
Lab ID:	1208F48-009	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
POLYCHLORINATED BIPHENYLS SW8082A				**(SW3510C)**				
Aroclor 1016	BRL	5.0		ug/L	165689	1	08/29/2012 11:37	SN
Aroclor 1221	BRL	5.0		ug/L	165689	1	08/29/2012 11:37	SN
Aroclor 1232	BRL	5.0		ug/L	165689	1	08/29/2012 11:37	SN
Aroclor 1242	BRL	5.0		ug/L	165689	1	08/29/2012 11:37	SN
Aroclor 1248	BRL	5.0		ug/L	165689	1	08/29/2012 11:37	SN
Aroclor 1254	BRL	5.0		ug/L	165689	1	08/29/2012 11:37	SN
Aroclor 1260	BRL	5.0		ug/L	165689	1	08/29/2012 11:37	SN
Surr: Decachlorobiphenyl	72.1	15.5-128		%REC	165689	1	08/29/2012 11:37	SN
Surr: Tetrachloro-m-xylene	78.5	17.3-125		%REC	165689	1	08/29/2012 11:37	SN

Qualifiers:	* Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
	BRL Below reporting limit	S	Spike Recovery outside limits due to matrix
	H Holding times for preparation or analysis exceeded	Narr	See case narrative
	N Analyte not NELAC certified	NC	Not confirmed
	B Analyte detected in the associated method blank	<	Less than Result value
	> Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TRIP BLANK
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012
Lab ID:	1208F48-010	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5030B)				
1,1,1-Trichloroethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,1,2,2-Tetrachloroethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,1,2-Trichloroethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,1-Dichloroethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,1-Dichloroethene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,2,4-Trichlorobenzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,2-Dibromo-3-chloropropane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,2-Dibromoethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,2-Dichlorobenzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,2-Dichloroethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,2-Dichloropropane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,3-Dichlorobenzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
1,4-Dichlorobenzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
2-Butanone	BRL	50		ug/L	165773	1	08/29/2012 04:28	NP
2-Hexanone	BRL	10		ug/L	165773	1	08/29/2012 04:28	NP
4-Methyl-2-pentanone	BRL	10		ug/L	165773	1	08/29/2012 04:28	NP
Acetone	BRL	50		ug/L	165773	1	08/29/2012 04:28	NP
Benzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Bromodichloromethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Bromoform	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Bromomethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Carbon disulfide	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Carbon tetrachloride	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Chlorobenzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Chloroethane	BRL	10		ug/L	165773	1	08/29/2012 04:28	NP
Chloroform	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Chloromethane	BRL	10		ug/L	165773	1	08/29/2012 04:28	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
cis-1,3-Dichloropropene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Cyclohexane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Dibromochloromethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Dichlorodifluoromethane	BRL	10		ug/L	165773	1	08/29/2012 04:28	NP
Ethylbenzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Freon-113	BRL	10		ug/L	165773	1	08/29/2012 04:28	NP
Isopropylbenzene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
m,p-Xylene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Methyl acetate	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Methyl tert-butyl ether	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Methylcyclohexane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Methylene chloride	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
o-Xylene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Aug-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TRIP BLANK
Project Name:	Liddell Drive	**Collection Date:**	8/20/2012
Lab ID:	1208F48-010	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
Styrene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Tetrachloroethene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Toluene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
trans-1,3-Dichloropropene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Trichloroethene	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Trichlorofluoromethane	BRL	5.0		ug/L	165773	1	08/29/2012 04:28	NP
Vinyl chloride	BRL	2.0		ug/L	165773	1	08/29/2012 04:28	NP
Surr: 4-Bromofluorobenzene	96.5	67.4-123		%REC	165773	1	08/29/2012 04:28	NP
Surr: Dibromofluoromethane	107	75.5-128		%REC	165773	1	08/29/2012 04:28	NP
Surr: Toluene-d8	96.2	70-120		%REC	165773	1	08/29/2012 04:28	NP

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc.

Sample/Cooler Receipt Checklist

Client United Work Order Number 1208F48

Checklist completed by [signature] (Signature) 8/10/12 (Date)

Carrier name: FedEx __ UPS __ Courier __ Client ✓ US Mail __ Other ______

Shipping container/cooler in good condition? Yes ✓ No __ Not Present __

Custody seals intact on shipping container/cooler? Yes __ No __ Not Present ✓

Custody seals intact on sample bottles? Yes __ No __ Not Present ✓

Container/Temp Blank temperature in compliance? (4°C±2)* Yes ✓ No __

Cooler #1 3.1° Cooler #2 ______ Cooler #3 ______ Cooler #4 ______ Cooler#5 ______ Cooler #6 ______

Chain of custody present? Yes ✓ No __

Chain of custody signed when relinquished and received? Yes ✓ No __

Chain of custody agrees with sample labels? Yes __ No ✓

Samples in proper container/bottle? Yes ✓ No __

Sample containers intact? Yes ✓ No __

Sufficient sample volume for indicated test? Yes ✓ No __

All samples received within holding time? Yes ✓ No __

Was TAT marked on the COC? Yes ✓ No __

Proceed with Standard TAT as per project history? Yes __ No __ Not Applicable ✓

Water - VOA vials have zero headspace? No VOA vials submitted __ Yes ✓ No __

Water - pH acceptable upon receipt? Yes ✓ No __ Not Applicable __

Adjusted? ______ Checked by DM

Sample Condition: Good ✓ Other(Explain) ______

(For diffusive samples or AIHA lead) Is a known blank included? Yes __ No ✓

See Case Narrative for resolution of the Non-Conformance.

* Samples do not have to comply with the given range for certain parameters.

\L\Quality Assurance\Checklists Procedures Sign-Off Templates\Checklists\Sample Receipt Checklists\Sample_Cooler_Receipt_Checklist

Client: United Consulting Group Inc.
Project: Liddell Drive
Lab Order: 1208F48

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
1208F48-001A	T-5-2'	8/20/2012 11:15:00AM	Soil	GASOLINE RANGE ORGANICS		08/22/2012	08/23/2012
1208F48-001B	T-5-2'	8/20/2012 11:15:00AM	Soil	PERCENT MOISTURE			08/24/2012
1208F48-001C	T-5-2'	8/20/2012 11:15:00AM	Soil	DIESEL RANGE ORGANICS		08/23/2012	08/23/2012
1208F48-001D	T-5-2'	8/20/2012 11:15:00AM	Soil	TOTAL METALS BY ICP		08/22/2012	08/23/2012
1208F48-001E	T-5-2'	8/20/2012 11:15:00AM	Soil	ICP METALS, TCLP Leached	08/22/2012	08/23/2012	08/23/2012
1208F48-002A	T-5-8'	8/20/2012 11:35:00AM	Soil	GASOLINE RANGE ORGANICS		08/22/2012	08/23/2012
1208F48-002B	T-5-8'	8/20/2012 11:35:00AM	Soil	PERCENT MOISTURE			08/24/2012
1208F48-002C	T-5-8'	8/20/2012 11:35:00AM	Soil	DIESEL RANGE ORGANICS		08/23/2012	08/23/2012
1208F48-002D	T-5-8'	8/20/2012 11:35:00AM	Soil	TOTAL METALS BY ICP		08/22/2012	08/23/2012
1208F48-002E	T-5-8'	8/20/2012 11:35:00AM	Soil	ICP METALS, TCLP Leached	08/22/2012	08/23/2012	08/23/2012
1208F48-003A	T-7-2'	8/20/2012 1:10:00PM	Soil	TOTAL METALS BY ICP		08/22/2012	08/23/2012
1208F48-003A	T-7-2'	8/20/2012 1:10:00PM	Soil	TOTAL METALS BY ICP		08/22/2012	08/24/2012
1208F48-003A	T-7-2'	8/20/2012 1:10:00PM	Soil	MERCURY		08/22/2012	08/22/2012
1208F48-003A	T-7-2'	8/20/2012 1:10:00PM	Soil	PERCENT MOISTURE			08/24/2012
1208F48-004A	T-7-8'	8/20/2012 1:25:00PM	Soil	TOTAL METALS BY ICP		08/22/2012	08/23/2012
1208F48-004A	T-7-8'	8/20/2012 1:25:00PM	Soil	TOTAL METALS BY ICP		08/22/2012	08/24/2012
1208F48-004A	T-7-8'	8/20/2012 1:25:00PM	Soil	MERCURY		08/22/2012	08/22/2012
1208F48-004A	T-7-8'	8/20/2012 1:25:00PM	Soil	PERCENT MOISTURE			08/24/2012
1208F48-005A	T-7-8A	8/20/2012 1:25:00PM	Soil	TOTAL METALS BY ICP		08/22/2012	08/23/2012
1208F48-005A	T-7-8A	8/20/2012 1:25:00PM	Soil	TOTAL METALS BY ICP		08/22/2012	08/24/2012
1208F48-005A	T-7-8A	8/20/2012 1:25:00PM	Soil	MERCURY		08/22/2012	08/22/2012
1208F48-005A	T-7-8A	8/20/2012 1:25:00PM	Soil	PERCENT MOISTURE			08/24/2012
1208F48-006A	T-8-2'	8/20/2012 10:25:00AM	Soil	TOTAL METALS BY ICP		08/22/2012	08/23/2012
1208F48-006A	T-8-2'	8/20/2012 10:25:00AM	Soil	TOTAL METALS BY ICP		08/22/2012	08/24/2012
1208F48-006A	T-8-2'	8/20/2012 10:25:00AM	Soil	MERCURY		08/22/2012	08/22/2012
1208F48-006A	T-8-2'	8/20/2012 10:25:00AM	Soil	PERCENT MOISTURE			08/24/2012
1208F48-007A	T-8-8'	8/20/2012 10:35:00AM	Soil	MERCURY, TCLP Leached	08/28/2012	08/29/2012	08/29/2012
1208F48-007A	T-8-8'	8/20/2012 10:35:00AM	Soil	ICP METALS, TCLP Leached	08/28/2012	08/29/2012	08/29/2012
1208F48-007A	T-8-8'	8/20/2012 10:35:00AM	Soil	TOTAL METALS BY ICP		08/22/2012	08/23/2012

Analytical Environmental Services, Inc

Date: 30-Aug-12

Client: United Consulting Group Inc.
Project: Liddell Drive
Lab Order: 1208F48

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
1208F48-007A	T-8-8'	8/20/2012 10:35:00AM	Soil	TOTAL METALS BY ICP		08/22/2012	08/24/2012
1208F48-007A	T-8-8'	8/20/2012 10:35:00AM	Soil	MERCURY		08/22/2012	08/22/2012
1208F48-007A	T-8-8'	8/20/2012 10:35:00AM	Soil	PERCENT MOISTURE			08/24/2012
1208F48-008A	B-1	8/20/2012 1:40:00PM	Aqueous	POLYCHLORINATED BIPHENYLS		08/24/2012	08/27/2012
1208F48-009A	C-1	8/20/2012 1:40:00PM	Soil	POLYCHLORINATED BIPHENYLS		08/28/2012	08/29/2012
1208F48-010A	TRIP BLANK	8/20/2012 12:00:00AM	Aqueous	TCL VOLATILE ORGANICS		08/29/2012	08/29/2012

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165447

Sample ID: MB-165447	Client ID:				Units: mg/Kg		Prep Date: 08/22/2012		Run No: 227519
SampleType: MBLK	TestCode: TOTAL MERCURY SW7471B				BatchID: 165447		Analysis Date: 08/22/2012		Seq No: 4761690
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	BRL	0.100	0	0	0	0	0	0	0	0	

Sample ID: LCS-165447	Client ID:				Units: mg/Kg		Prep Date: 08/22/2012		Run No: 227519
SampleType: LCS	TestCode: TOTAL MERCURY SW7471B				BatchID: 165447		Analysis Date: 08/22/2012		Seq No: 4761692
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.4212	0.100	0.4	0	105	80	120	0	0	0	

Sample ID: 1208G12-001EMS	Client ID:				Units: mg/Kg-dry		Prep Date: 08/22/2012		Run No: 227519
SampleType: MS	TestCode: TOTAL MERCURY SW7471B				BatchID: 165447		Analysis Date: 08/22/2012		Seq No: 4761696
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.5251	0.120	0.4792	0	110	70	130	0	0	0	

Sample ID: 1208G12-001EMSD	Client ID:				Units: mg/Kg-dry		Prep Date: 08/22/2012		Run No: 227519
SampleType: MSD	TestCode: TOTAL MERCURY SW7471B				BatchID: 165447		Analysis Date: 08/22/2012		Seq No: 4761698
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.5193	0.119	0.4773	0	109	70	130	0.5251	1.1	30	

Qualifiers:					
	» Greater than Result value	« Less than Result value	B Analyte detected in the associated method blank		
	BRL Below reporting limit	E Estimated (value above quantitation range)	H Holding times for preparation or analysis exceeded		
	J Estimated value detected below Reporting Limit	N Analyte not NELAC certified	R RPD outside limits due to matrix		
	Rpt Lim Reporting Limit	S Spike Recovery outside limits due to matrix			

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165456

Sample ID: MB-165456	Client ID:				Units: mg/L		Prep Date: 08/22/2012		Run No: 227569
SampleType: MBLK	TestCode: ICP METALS, TCLP SW1311/6010C				BatchID: 165456		Analysis Date: 08/22/2012		Seq No: 4762842

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	BRL	0.0500	0	0	0	0	0	0	0	0	

Sample ID: MB-165456-2	Client ID:				Units: mg/L		Prep Date: 08/23/2012		Run No: 227569
SampleType: MBLK	TestCode: ICP METALS, TCLP SW1311/6010C				BatchID: 165456		Analysis Date: 08/23/2012		Seq No: 4765223

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	BRL	0.0500	0	0	0	0	0	0	0	0	

Sample ID: LCS-165456	Client ID:				Units: mg/L		Prep Date: 08/22/2012		Run No: 227569
SampleType: LCS	TestCode: ICP METALS, TCLP SW1311/6010C				BatchID: 165456		Analysis Date: 08/22/2012		Seq No: 4762838

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	4.812	0.0500	5	0	96.2	85	115	0	0	0	

Sample ID: 1208G00-001CMS	Client ID:				Units: mg/L		Prep Date: 08/22/2012		Run No: 227569
SampleType: MS	TestCode: ICP METALS, TCLP SW1311/6010C				BatchID: 165456		Analysis Date: 08/22/2012		Seq No: 4762861

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	4.856	0.0500	5	0.008082	97	50	150	0	0	0	

Sample ID: 1208G00-001CMSD	Client ID:				Units: mg/L		Prep Date: 08/22/2012		Run No: 227569
SampleType: MSD	TestCode: ICP METALS, TCLP SW1311/6010C				BatchID: 165456		Analysis Date: 08/22/2012		Seq No: 4762865

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	4.873	0.0500	5	0.008082	97.3	50	150	4.856	0.335	30	

Qualifiers:					
>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165458

Sample ID: MB-165458	Client ID:			Units: mg/Kg		Prep Date: 08/22/2012		Run No: 227623	
SampleType: MBLK	TestCode: METALS, TOTAL SW6010C			BatchID: 165458		Analysis Date: 08/23/2012		Seq No: 4763903	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	5.00	0	0	0	0	0	0	0	0	
Barium	BRL	5.00	0	0	0	0	0	0	0	0	
Cadmium	BRL	2.50	0	0	0	0	0	0	0	0	
Chromium	BRL	2.50	0	0	0	0	0	0	0	0	
Lead	BRL	5.00	0	0	0	0	0	0	0	0	
Selenium	BRL	5.00	0	0	0	0	0	0	0	0	
Silver	BRL	2.50	0	0	0	0	0	0	0	0	

Sample ID: LCS-165458	Client ID:			Units: mg/Kg		Prep Date: 08/22/2012		Run No: 227623	
SampleType: LCS	TestCode: METALS, TOTAL SW6010C			BatchID: 165458		Analysis Date: 08/23/2012		Seq No: 4763900	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	45.38	5.00	50	0.3676	90	80	120	0	0	0	
Barium	49.38	5.00	50	0.1072	98.6	80	120	0	0	0	
Cadmium	48.40	2.50	50	0	96.8	80	120	0	0	0	
Chromium	50.02	2.50	50	0.1274	99.8	80	120	0	0	0	
Lead	46.25	5.00	50	0.3235	91.9	80	120	0	0	0	
Selenium	43.54	5.00	50	0	87.1	80	120	0	0	0	
Silver	4.913	2.50	5	0	98.3	80	120	0	0	0	

Sample ID: 1208F48-003AMS	Client ID: T-7-2'			Units: mg/Kg-dry		Prep Date: 08/22/2012		Run No: 227623	
SampleType: MS	TestCode: METALS, TOTAL SW6010C			BatchID: 165458		Analysis Date: 08/23/2012		Seq No: 4763909	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	58.06	5.85	58.54	6.142	88.7	75	125	0	0	0	
Barium	290.5	5.85	58.54	198.5	157	75	125	0	0	0	S
Cadmium	56.79	2.93	58.54	2.100	93.4	75	125	0	0	0	
Chromium	109.7	2.93	58.54	43.27	113	75	125	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165458

Sample ID: **1208F48-003AMS** Client ID: **T-7-2'** Units: **mg/Kg-dry** Prep Date: **08/22/2012** Run No: **227623**
SampleType: **MS** TestCode: **METALS, TOTAL SW6010C** BatchID: **165458** Analysis Date: **08/23/2012** Seq No: **4763909**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	1250	5.85	58.54	735.0	880	75	125	0	0	0	S
Selenium	41.80	5.85	58.54	0	71.4	75	125	0	0	0	S
Silver	8.987	2.93	5.854	4.133	82.9	75	125	0	0	0	

Sample ID: **1208F48-003AMSD** Client ID: **T-7-2'** Units: **mg/Kg-dry** Prep Date: **08/22/2012** Run No: **227623**
SampleType: **MSD** TestCode: **METALS, TOTAL SW6010C** BatchID: **165458** Analysis Date: **08/23/2012** Seq No: **4763911**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	57.97	5.88	58.77	6.142	88.2	75	125	58.06	0.161	20	
Barium	227.3	5.88	58.77	198.5	49.1	75	125	290.5	24.4	20	SR
Cadmium	54.20	2.94	58.77	2.100	88.7	75	125	56.79	4.66	20	
Chromium	95.42	2.94	58.77	43.27	88.7	75	125	109.7	13.9	20	
Lead	655.8	5.88	58.77	735.0	-135	75	125	1250	62.4	20	SR
Selenium	36.58	5.88	58.77	0	62.2	75	125	41.80	13.3	20	S
Silver	7.718	2.94	5.877	4.133	61	75	125	8.987	15.2	20	S

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165528

Sample ID: MB-165528	Client ID:				Units: mg/Kg		Prep Date: 08/22/2012		Run No: 227567	
SampleType: MBLK	TestCode: GASOLINE RANGE ORGANICS SW8015C				BatchID: 165528		Analysis Date: 08/22/2012		Seq No: 4762822	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Gasoline Range Organics)	BRL	0.50	0	0	0	0	0	0	0	0	
Surr: a.a.a-trifluorotoluene	0.04750	0	0.05	0	95	65.2	152	0	0	0	

Sample ID: LCS-165528	Client ID:				Units: mg/Kg		Prep Date: 08/22/2012		Run No: 227567	
SampleType: LCS	TestCode: GASOLINE RANGE ORGANICS SW8015C				BatchID: 165528		Analysis Date: 08/22/2012		Seq No: 4762811	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Gasoline Range Organics)	1.025	0.50	1	0	102	64.6	126	0	0	0	
Surr: a.a.a-trifluorotoluene	0.05187	0	0.05	0	104	65.2	152	0	0	0	

Sample ID: 1208E51-021AMS	Client ID:				Units: mg/Kg-dry		Prep Date: 08/22/2012		Run No: 227567	
SampleType: MS	TestCode: GASOLINE RANGE ORGANICS SW8015C				BatchID: 165528		Analysis Date: 08/22/2012		Seq No: 4762814	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Gasoline Range Organics)	1.216	0.62	1.233	0	98.6	54.7	130	0	0	0	H
Surr: a.a.a-trifluorotoluene	0.06214	0	0.0616	0	101	65.2	152	0	0	0	H

Sample ID: 1208E51-021AMSD	Client ID:				Units: mg/Kg-dry		Prep Date: 08/22/2012		Run No: 227567	
SampleType: MSD	TestCode: GASOLINE RANGE ORGANICS SW8015C				BatchID: 165528		Analysis Date: 08/22/2012		Seq No: 4762818	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Gasoline Range Organics)	1.191	0.62	1.233	0	96.6	54.7	130	1.216	2.11	16.1	H
Surr: a.a.a-trifluorotoluene	0.06189	0	0.0616	0	100	65.2	152	0.06214	0	0	H

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165531

Sample ID: MB-165531	Client ID:				Units: mg/Kg		Prep Date: 08/23/2012		Run No: 227589
SampleType: MBLK	TestCode: DIESEL RANGE ORGANICS SW8015C				BatchID: 165531		Analysis Date: 08/23/2012		Seq No: 4764138
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Diesel Range Organics)	BRL	6.7	0	0	0	0	0	0	0	0	
Surr: Dioctylphthalate	2.323	0	3.3	0	70.4	47.4	128	0	0	0	

Sample ID: LCS-165531	Client ID:				Units: mg/Kg		Prep Date: 08/23/2012		Run No: 227589
SampleType: LCS	TestCode: DIESEL RANGE ORGANICS SW8015C				BatchID: 165531		Analysis Date: 08/23/2012		Seq No: 4764141
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Diesel Range Organics)	20.00	6.7	33.3	0	60.1	51.4	120	0	0	0	
Surr: Dioctylphthalate	2.292	0	3.33	0	68.8	47.4	128	0	0	0	

Sample ID: 1208G28-003BMS	Client ID:				Units: mg/Kg-dry		Prep Date: 08/23/2012		Run No: 227589
SampleType: MS	TestCode: DIESEL RANGE ORGANICS SW8015C				BatchID: 165531		Analysis Date: 08/23/2012		Seq No: 4764164
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Diesel Range Organics)	31.81	8.6	42.53	2.093	69.9	35.2	118	0	0	0	
Surr: Dioctylphthalate	3.583	0	4.253	0	84.3	47.4	128	0	0	0	

Sample ID: 1208G28-003BMSD	Client ID:				Units: mg/Kg-dry		Prep Date: 08/23/2012		Run No: 227589
SampleType: MSD	TestCode: DIESEL RANGE ORGANICS SW8015C				BatchID: 165531		Analysis Date: 08/23/2012		Seq No: 4764168
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
TPH (Diesel Range Organics)	31.73	8.6	42.54	2.093	69.7	35.2	118	31.81	0.263	27.6	
Surr: Dioctylphthalate	3.531	0	4.254	0	83	47.4	128	3.583	0	0	

Qualifiers:					
>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165583

Sample ID: MB-165583	Client ID:				Units: ug/L		Prep Date: 08/24/2012		Run No: 227832
SampleType: MBLK	TestCode: POLYCHLORINATED BIPHENYLS SW8082A				BatchID: 165583		Analysis Date: 08/27/2012		Seq No: 4768158

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Aroclor 1016	BRL	0.50	0	0	0	0	0	0	0	0	
Aroclor 1221	BRL	0.50	0	0	0	0	0	0	0	0	
Aroclor 1232	BRL	0.50	0	0	0	0	0	0	0	0	
Aroclor 1242	BRL	0.50	0	0	0	0	0	0	0	0	
Aroclor 1248	BRL	0.50	0	0	0	0	0	0	0	0	
Aroclor 1254	BRL	0.50	0	0	0	0	0	0	0	0	
Aroclor 1260	BRL	0.50	0	0	0	0	0	0	0	0	
Surr: Decachlorobiphenyl	0.4213	0	0.5	0	84.3	15.5	128	0	0	0	
Surr: Tetrachloro-m-xylene	0.4129	0	0.5	0	82.6	17.3	125	0	0	0	

Sample ID: LCS-165583	Client ID:				Units: ug/L		Prep Date: 08/24/2012		Run No: 227832
SampleType: LCS	TestCode: POLYCHLORINATED BIPHENYLS SW8082A				BatchID: 165583		Analysis Date: 08/27/2012		Seq No: 4768165

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Aroclor 1016	4.352	0.50	5	0	87	56.3	135	0	0	0	
Aroclor 1260	4.455	0.50	5	0	89.1	62.6	135	0	0	0	
Surr: Decachlorobiphenyl	0.4160	0	0.5	0	83.2	15.5	128	0	0	0	
Surr: Tetrachloro-m-xylene	0.4558	0	0.5	0	91.2	17.3	125	0	0	0	

Sample ID: 1208G44-002CMS	Client ID:				Units: ug/L		Prep Date: 08/24/2012		Run No: 227832
SampleType: MS	TestCode: POLYCHLORINATED BIPHENYLS SW8082A				BatchID: 165583		Analysis Date: 08/27/2012		Seq No: 4768167

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Aroclor 1016	4.064	0.50	5	0	81.3	33.8	140	0	0	0	
Aroclor 1260	4.127	0.50	5	0	82.5	33.3	140	0	0	0	
Surr: Decachlorobiphenyl	0.3496	0	0.5	0	69.9	15.5	128	0	0	0	
Surr: Tetrachloro-m-xylene	0.3871	0	0.5	0	77.4	17.3	125	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165583

Sample ID: 1208G44-002CMSD	Client ID:				Units: ug/L		Prep Date: 08/24/2012		Run No: 227832		
SampleType: MSD	TestCode: POLYCHLORINATED BIPHENYLS SW8082A				BatchID: 165583		Analysis Date: 08/27/2012		Seq No: 4768170		
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Aroclor 1016	2.776	0.50	5	0	55.5	33.8	140	4.064	37.7	19.2	R
Aroclor 1260	4.242	0.50	5	0	84.8	33.3	140	4.127	2.74	19.4	
Surr: Decachlorobiphenyl	0.4306	0	0.5	0	86.1	15.5	128	0.3496	0	0	
Surr: Tetrachloro-m-xylene	0.1566	0	0.5	0	31.3	17.3	125	0.3871	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165689

Sample ID: MB-165689 Client ID: Units: ug/L Prep Date: 08/28/2012 Run No: 227938
SampleType: MBLK TestCode: POLYCHLORINATED BIPHENYLS SW8082A BatchID: 165689 Analysis Date: 08/29/2012 Seq No: 4770910

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Aroclor 1016	BRL	5.0	0	0	0	0	0	0	0	0	
Aroclor 1221	BRL	5.0	0	0	0	0	0	0	0	0	
Aroclor 1232	BRL	5.0	0	0	0	0	0	0	0	0	
Aroclor 1242	BRL	5.0	0	0	0	0	0	0	0	0	
Aroclor 1248	BRL	5.0	0	0	0	0	0	0	0	0	
Aroclor 1254	BRL	5.0	0	0	0	0	0	0	0	0	
Aroclor 1260	BRL	5.0	0	0	0	0	0	0	0	0	
Surr: Decachlorobiphenyl	3.725	0	5	0	74.5	15.5	128	0	0	0	
Surr: Tetrachloro-m-xylene	3.425	0	5	0	68.5	17.3	125	0	0	0	

Sample ID: LCS-165689 Client ID: Units: ug/L Prep Date: 08/28/2012 Run No: 227938
SampleType: LCS TestCode: POLYCHLORINATED BIPHENYLS SW8082A BatchID: 165689 Analysis Date: 08/29/2012 Seq No: 4770933

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Aroclor 1016	39.88	5.0	50	0	79.8	56.3	135	0	0	0	
Aroclor 1260	42.54	5.0	50	0	85.1	62.6	135	0	0	0	
Surr: Decachlorobiphenyl	3.670	0	5	0	73.4	15.5	128	0	0	0	
Surr: Tetrachloro-m-xylene	3.644	0	5	0	72.9	17.3	125	0	0	0	

Sample ID: 1208F48-009AMS Client ID: C-1 Units: ug/L Prep Date: 08/28/2012 Run No: 227938
SampleType: MS TestCode: POLYCHLORINATED BIPHENYLS SW8082A BatchID: 165689 Analysis Date: 08/29/2012 Seq No: 4771041

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Aroclor 1016	45.57	5.0	50	0	91.1	33.8	140	0	0	0	
Aroclor 1260	42.94	5.0	50	0	85.9	33.3	140	0	0	0	
Surr: Decachlorobiphenyl	3.806	0	5	0	76.1	15.5	128	0	0	0	
Surr: Tetrachloro-m-xylene	4.078	0	5	0	81.6	17.3	125	0	0	0	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165764

Sample ID: MB-165764	Client ID:				Units: mg/L		Prep Date: 08/29/2012		Run No: 227960
SampleType: MBLK	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 165764		Analysis Date: 08/29/2012		Seq No: 4771477
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	BRL	0.00400	0	0	0	0	0	0	0	0	

Sample ID: LCS-165764	Client ID:				Units: mg/L		Prep Date: 08/29/2012		Run No: 227960
SampleType: LCS	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 165764		Analysis Date: 08/29/2012		Seq No: 4771478
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.03978	0.00400	0.04	0	99.4	80	120	0	0	0	

Sample ID: 1208K82-002BMS	Client ID:				Units: mg/L		Prep Date: 08/29/2012		Run No: 227960
SampleType: MS	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 165764		Analysis Date: 08/29/2012		Seq No: 4771482
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.03925	0.00400	0.04	0	98.1	80	120	0	0	0	

Sample ID: 1208K82-002BMSD	Client ID:				Units: mg/L		Prep Date: 08/29/2012		Run No: 227960
SampleType: MSD	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 165764		Analysis Date: 08/29/2012		Seq No: 4771483
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.03894	0.00400	0.04	0	97.4	80	120	0.03925	0.785	20	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165769

Sample ID: MB-165769	Client ID:			Units: mg/L	Prep Date: 08/29/2012	Run No: 227959
SampleType: MBLK	TestCode: ICP METALS, TCLP SW1311/6010C			BatchID: 165769	Analysis Date: 08/29/2012	Seq No: 4771461

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	0.250	0	0	0	0	0	0	0	0	
Barium	BRL	0.500	0	0	0	0	0	0	0	0	
Cadmium	BRL	0.0250	0	0	0	0	0	0	0	0	
Chromium	BRL	0.0500	0	0	0	0	0	0	0	0	
Lead	BRL	0.0500	0	0	0	0	0	0	0	0	
Selenium	BRL	0.100	0	0	0	0	0	0	0	0	
Silver	BRL	0.0250	0	0	0	0	0	0	0	0	

Sample ID: MB-165769-2	Client ID:			Units: mg/L	Prep Date: 08/29/2012	Run No: 227959
SampleType: MBLK	TestCode: ICP METALS, TCLP SW1311/6010C			BatchID: 165769	Analysis Date: 08/30/2012	Seq No: 4773629

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	0.0500	0	0	0	0	0	0	0	0	
Barium	BRL	0.100	0	0	0	0	0	0	0	0	
Cadmium	BRL	0.00500	0	0	0	0	0	0	0	0	
Chromium	BRL	0.0100	0	0	0	0	0	0	0	0	
Lead	BRL	0.0100	0	0	0	0	0	0	0	0	
Selenium	BRL	0.0200	0	0	0	0	0	0	0	0	
Silver	BRL	0.00500	0	0	0	0	0	0	0	0	

Sample ID: LCS-165769	Client ID:			Units: mg/L	Prep Date: 08/29/2012	Run No: 227959
SampleType: LCS	TestCode: ICP METALS, TCLP SW1311/6010C			BatchID: 165769	Analysis Date: 08/29/2012	Seq No: 4771460

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.544	0.250	5	0	111	85	115	0	0	0	
Barium	5.166	0.500	5	0	103	80	120	0	0	0	
Cadmium	5.317	0.0250	5	0	106	85	115	0	0	0	
Chromium	5.381	0.0500	5	0	108	85	115	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165769

Sample ID: LCS-165769	Client ID:			Units: mg/L	Prep Date: 08/29/2012	Run No: 227959
SampleType: LCS	TestCode: ICP METALS, TCLP	SW1311/6010C		BatchID: 165769	Analysis Date: 08/29/2012	Seq No: 4771460

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	5.197	0.0500	5	0	104	85	115	0	0	0	
Selenium	5.600	0.100	5	0	112	85	115	0	0	0	
Silver	0.5264	0.0250	0.5	0	105	85	115	0	0	0	

Sample ID: 1208J63-003EMS	Client ID:			Units: mg/L	Prep Date: 08/29/2012	Run No: 227959
SampleType: MS	TestCode: ICP METALS, TCLP	SW1311/6010C		BatchID: 165769	Analysis Date: 08/29/2012	Seq No: 4771463

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.461	0.250	5	0	109	50	150	0	0	0	
Barium	5.222	0.500	5	0.1230	102	50	150	0	0	0	
Cadmium	5.274	0.0250	5	0	105	50	150	0	0	0	
Chromium	5.313	0.0500	5	0.02747	106	50	150	0	0	0	
Lead	5.114	0.0500	5	0	102	50	150	0	0	0	
Selenium	5.553	0.100	5	0	111	50	150	0	0	0	
Silver	0.5175	0.0250	0.5	0	104	50	150	0	0	0	

Sample ID: 1208J63-003EMSD	Client ID:			Units: mg/L	Prep Date: 08/29/2012	Run No: 227959
SampleType: MSD	TestCode: ICP METALS, TCLP	SW1311/6010C		BatchID: 165769	Analysis Date: 08/29/2012	Seq No: 4771464

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.493	0.250	5	0	110	50	150	5.461	0.573	30	
Barium	5.218	0.500	5	0.1230	102	50	150	5.222	0.091	30	
Cadmium	5.285	0.0250	5	0	106	50	150	5.274	0.208	30	
Chromium	5.324	0.0500	5	0.02747	106	50	150	5.313	0.219	30	
Lead	5.110	0.0500	5	0	102	50	150	5.114	0.064	30	
Selenium	5.595	0.100	5	0	112	50	150	5.553	0.744	30	
Silver	0.5186	0.0250	0.5	0	104	50	150	0.5175	0.2	30	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165773

Sample ID: MB-165773 Client ID: Units: ug/L Prep Date: 08/29/2012 Run No: 227933
SampleType: MBLK TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 165773 Analysis Date: 08/29/2012 Seq No: 4770672

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2,2-Tetrachloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2,4-Trichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromo-3-chloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromoethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,3-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,4-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
2-Butanone	BRL	50	0	0	0	0	0	0	0	0	
2-Hexanone	BRL	10	0	0	0	0	0	0	0	0	
4-Methyl-2-pentanone	BRL	10	0	0	0	0	0	0	0	0	
Acetone	BRL	50	0	0	0	0	0	0	0	0	
Benzene	BRL	5.0	0	0	0	0	0	0	0	0	
Bromodichloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Bromoform	BRL	5.0	0	0	0	0	0	0	0	0	
Bromomethane	BRL	5.0	0	0	0	0	0	0	0	0	
Carbon disulfide	BRL	5.0	0	0	0	0	0	0	0	0	
Carbon tetrachloride	BRL	5.0	0	0	0	0	0	0	0	0	
Chlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Chloroethane	BRL	10	0	0	0	0	0	0	0	0	
Chloroform	BRL	5.0	0	0	0	0	0	0	0	0	
Chloromethane	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165773

Sample ID: MB-165773 Client ID: Units: ug/L Prep Date: 08/29/2012 Run No: 227933
SampleType: MBLK TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 165773 Analysis Date: 08/29/2012 Seq No: 4770672

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
cis-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
cis-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Cyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Dibromochloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Dichlorodifluoromethane	BRL	10	0	0	0	0	0	0	0	0	
Ethylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Freon-113	BRL	10	0	0	0	0	0	0	0	0	
Isopropylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
m,p-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl acetate	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl tert-butyl ether	BRL	5.0	0	0	0	0	0	0	0	0	
Methylcyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Methylene chloride	BRL	5.0	0	0	0	0	0	0	0	0	
o-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Styrene	BRL	5.0	0	0	0	0	0	0	0	0	
Tetrachloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Toluene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichlorofluoromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Vinyl chloride	BRL	2.0	0	0	0	0	0	0	0	0	
Surr: 4-Bromofluorobenzene	47.81	0	50	0	95.6	67.4	123	0	0	0	
Surr: Dibromofluoromethane	58.47	0	50	0	117	75.5	128	0	0	0	
Surr: Toluene-d8	49.48	0	50	0	99	70	120	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165773

Sample ID: LCS-165773 Client ID: Units: ug/L Prep Date: 08/29/2012 Run No: 227933
SampleType: LCS TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 165773 Analysis Date: 08/29/2012 Seq No: 4770661

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	49.26	5.0	50	0	98.5	60	140	0	0	0	
Benzene	51.08	5.0	50	0	102	70	130	0	0	0	
Chlorobenzene	46.92	5.0	50	0	93.8	70	130	0	0	0	
Toluene	51.47	5.0	50	0	103	70	130	0	0	0	
Trichloroethene	52.26	5.0	50	0	105	70	130	0	0	0	
Surr: 4-Bromofluorobenzene	50.01	0	50	0	100	67.4	123	0	0	0	
Surr: Dibromofluoromethane	52.31	0	50	0	105	75.5	128	0	0	0	
Surr: Toluene-d8	48.96	0	50	0	97.9	70	120	0	0	0	

Sample ID: 1208J49-007AMS Client ID: Units: ug/L Prep Date: 08/29/2012 Run No: 227933
SampleType: MS TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 165773 Analysis Date: 08/29/2012 Seq No: 4770663

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	5306	250	2500	3042	90.6	50.1	179	0	0	0	
Benzene	2513	250	2500	0	101	61.2	150	0	0	0	
Chlorobenzene	2180	250	2500	0	87.2	72.1	140	0	0	0	
Toluene	2478	250	2500	0	99.1	58.7	154	0	0	0	
Trichloroethene	8749	250	2500	6113	105	68.3	149	0	0	0	
Surr: 4-Bromofluorobenzene	2594	0	2500	0	104	67.4	123	0	0	0	
Surr: Dibromofluoromethane	2718	0	2500	0	109	75.5	128	0	0	0	
Surr: Toluene-d8	2552	0	2500	0	102	70	120	0	0	0	

Sample ID: 1208J49-007AMSD Client ID: Units: ug/L Prep Date: 08/29/2012 Run No: 227933
SampleType: MSD TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 165773 Analysis Date: 08/29/2012 Seq No: 4770666

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	5366	250	2500	3042	93	50.1	179	5306	1.12	23.3	
Benzene	2568	250	2500	0	103	61.2	150	2513	2.18	19	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive
Workorder: 1208F48

ANALYTICAL QC SUMMARY REPORT

BatchID: 165773

Sample ID: **1208J49-007AMSD**	Client ID:					Units: **ug/L**		Prep Date: **08/29/2012**		Run No: **227933**	
SampleType: **MSD**	TestCode: **TCL VOLATILE ORGANICS SW8260B**					BatchID: **165773**		Analysis Date: **08/29/2012**		Seq No: **4770666**	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Chlorobenzene	2277	250	2500	0	91.1	72.1	140	2180	4.38	21.5	
Toluene	2560	250	2500	0	102	58.7	154	2478	3.26	20	
Trichloroethene	8992	250	2500	6113	115	68.3	149	8749	2.73	17.7	
Surr: 4-Bromofluorobenzene	2599	0	2500	0	104	67.4	123	2594	0	0	
Surr: Dibromofluoromethane	2769	0	2500	0	111	75.5	128	2718	0	0	
Surr: Toluene-d8	2493	0	2500	0	99.7	70	120	2552	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

AES

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

August 01, 2012

Britt Bickerstaff
United Consulting Group Inc.
625 Holcomb Bridge Rd
Norcross GA 30071

TEL: (770) 582-2788
FAX: (770) 582-2900

RE: Liddell Drive Equalization

Dear Britt Bickerstaff: Order No: 1207K20

Analytical Environmental Services, Inc. received 1 samples on July 25, 2012 5:13 pm for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the analyses contained herein will be noted and submitted in the form of a project Case Narrative.
AES' certifications are as follows:
-NELAC/Florida Certification number E87582 for analysis of Environmental Water, soil/hazardous waste, and Drinking Water Microbiology, effective 07/01/12-06/30/13.
-AIHA Certification ID #100671 for Industrial Hygiene samples (Organics, Inorganics), Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) effective until 09/01/13.

These results relate only to the items tested. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Kathryn F. Waters

Kathryn Waters
Project Manager

ANALYTICAL ENVIRONMENTAL SERVICES, INC
3785 Presidential Parkway, Atlanta GA 30340-3704
AES TEL.: (770) 457-8177 / TOLL-FREE (800) 972-4889 / FAX: (770) 457-8188

CHAIN OF CUSTODY

KEV 7/30/12

Work Order: 1207---0

Date: 7/25/12 Page 1 of 1

COMPANY: United Consulting
ADDRESS: 625 Holcomb Br. Rd Norcross GA 30071
PHONE: 678-410-8474
FAX:
SAMPLED BY: Britt B.
SIGNATURE: Britt Bullock

ANALYSIS REQUESTED: RCRA Metals; VOC's; SVOC's; TCLP-PLM; TCLP-VOC's/SVOC's

Visit our website www.aesatlanta.com to check on the status of your results, place bottle orders, etc.

#	SAMPLE ID	SAMPLED DATE	SAMPLED TIME	Grab	Composite	Matrix (See codes)	PRESERVATION (See codes)	REMARKS	No. # of Containers
1	TP-1 @ 1	7/25/12	8:00a	X		S	X		1
2	TP-1 @ 2.5	7/25/12	9:35	X		S	X X X		6
3	TP-2 @ 1	7/25/12	10:05a	X		S	X		1
4	TP-2 @ 6	7/25/12	10:30a	X		S	X X X		6
5	TP-3 @ 1	7/25/12	10:55a	X		S	X		1
6	TP-3 @ 3	7/25/12	11:10a	X		S	X X X		6
7	TP-4 @ 1	7/25/12	12:05	X		S	X		1
8	TP-4 @ 6	7/25/12	12:30	X		S	X X X		6
9	TP-4 @ 2.5	7/25/2	1:40	X		S	X X X		6
10	Duplicate	7/25/12	1:40	X		S	X X X		6
11	TP-1 to 4	7/6/12	12:40	X	X	S	X		1
12	TP-4 @ 2	7/25/12	11:40	X		S	X		1
13	Trip Blank	7/25/12				W	X		2
14	FB		4:00			W	X		1

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
1: Britt Bullock	7/25/12 5:13	1: Latoya P	7/25/12 5:13p
2:		2:	
3:		3:	

PROJECT INFORMATION
PROJECT NAME: Liddell Drive Equalization Proj.
PROJECT #: 2012.3532.01
SITE ADDRESS: Liddell Drive, Atlanta GA
SEND REPORT TO: Britt Bullock
INVOICE TO: (IF DIFFERENT FROM ABOVE)
QUOTE #: PO#:

RECEIPT
Total # of Containers: 43

Turnaround Time Request
- ○ Standard 5 Business Days
- ○ 2 Business Day Rush
- ☒ Next Business Day Rush
- ○ Same Day Rush (auth req.)
- ○ Other

STATE PROGRAM (if any):
E-mail? Y / N; Fax? Y / N
DATA PACKAGE: I II III IV

SPECIAL INSTRUCTIONS/COMMENTS:

SHIPMENT METHOD
OUT / / VIA:
IN / / VIA:
CLIENT FedEx UPS MAIL COURIER GREYHOUND OTHER

SAMPLES RECEIVED AFTER 3PM OR ON SATURDAY ARE CONSIDERED RECEIVED THE NEXT BUSINESS DAY. IF TURNAROUND TIME IS NOT INDICATED, AES WILL PROCEED WITH STANDARD TAT OF SAMPLES.
SAMPLES ARE DISPOSED 30 DAYS AFTER REPORT COMPLETION UNLESS OTHER ARRANGEMENTS ARE MADE.

MATRIX CODES: A = Air GW = Groundwater SE = Sediment SO = Soil SW = Surface Water W = Water (Blanks) DW = Drinking Water (Blanks) O = Other (specify) WW = Waste Water
PRESERVATIVE CODES: H+I = Hydrochloric acid + ice I = Ice only N = Nitric acid S+I = Sulfuric acid + ice S/M+I = Sodium Bisulfate/Methanol + ice O = Other (specify) NA = None

White Copy - Original; Yellow Copy - Client

Analytical Environmental Services, Inc

Date: 31-Jul-12

Client:	United Consulting Group Inc.
Project:	Liddell Drive Equalization
Lab ID:	1207K20

Case Narrative

Per email request from Russ Greibel on 7/30/12 at 10:24 am samples 1207H10-002C, 1207H10-003A, and 1207H10-004C should be composited into one sample and analyze for TCLP-RCRA Metals. The results for work order 1207K20 are due date is 7/31/12.

Analytical Environmental Services, Inc **Date:** 31-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-1@2.5/ TP-2@1/ TP-2@6
Project Name:	Liddell Drive Equalization	**Collection Date:**	7/25/2012 10:30:00 AM
Lab ID:	1207K20-001	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
MERCURY, TCLP SW1311/7470A				**(SW7470A)**				
Mercury	BRL	0.00400		mg/L	164432	1	07/31/2012 13:17	MW
ICP METALS, TCLP SW1311/6010C				**(SW3010A)**				
Arsenic	BRL	0.250		mg/L	164522	1	07/31/2012 13:22	MR
Barium	1.67	0.500		mg/L	164522	1	07/31/2012 13:22	MR
Cadmium	BRL	0.0250		mg/L	164522	1	07/31/2012 13:22	MR
Chromium	BRL	0.0500		mg/L	164522	1	07/31/2012 13:22	MR
Lead	1.70	0.0500		mg/L	164522	1	07/31/2012 13:22	MR
Selenium	BRL	0.100		mg/L	164522	1	07/31/2012 13:22	MR
Silver	BRL	0.0250		mg/L	164522	1	07/31/2012 13:22	MR

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc.

Sample/Cooler Receipt Checklist

KEW 7/30/12 1207K20

Client United Consulting Work Order Number 1207K20

Checklist completed by [signature] 07/25/2012
Signature Date

Carrier name: FedEx __ UPS __ Courier __ Client ✓ US Mail __ Other _____

Shipping container/cooler in good condition?	Yes ✓	No __	Not Present __
Custody seals intact on shipping container/cooler?	Yes __	No __	Not Present ✓
Custody seals intact on sample bottles?	Yes __	No __	Not Present ✓
Container/Temp Blank temperature in compliance? (4°C±2)*	Yes ✓	No __	

Cooler #1 3.7 Cooler #2 _____ Cooler #3 _____ Cooler #4 _____ Cooler#5 _____ Cooler #6 _____

Chain of custody present?	Yes ✓	No __
Chain of custody signed when relinquished and received?	Yes ✓	No __
Chain of custody agrees with sample labels?	Yes ✓	No __
Samples in proper container/bottle?	Yes ✓	No __
Sample containers intact?	Yes ✓	No __
Sufficient sample volume for indicated test?	Yes ✓	No __
All samples received within holding time?	Yes ✓	No __
Was TAT marked on the COC?	Yes ✓	No __
Proceed with Standard TAT as per project history?	Yes __	No __ Not Applicable ✓
Water - VOA vials have zero headspace?	No VOA vials submitted ✓	Yes __ No __
Water - pH acceptable upon receipt?	Yes ✓	No __ Not Applicable __

Adjusted? _____ Checked by AM

Sample Condition: Good ✓ Other(Explain) _____

(For diffusive samples or AIHA lead) Is a known blank included? Yes __ No ✓

See Case Narrative for resolution of the Non-Conformance.

* Samples do not have to comply with the given range for certain parameters.

Client: United Consulting Group Inc.
Project: Liddell Drive Equalization
Lab Order: 1207K20

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
1207K20-001A	TP-1@2.5/ TP-2@1/ TP-2@6	7/25/2012 10:30:00AM	Soil	MERCURY, TCLP Leached	07/30/2012	07/31/2012	07/31/2012
1207K20-001A	TP-1@2.5/ TP-2@1/ TP-2@6	7/25/2012 10:30:00AM	Soil	ICP METALS, TCLP Leached	07/30/2012	07/31/2012	07/31/2012

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization
Workorder: 1207K20

ANALYTICAL QC SUMMARY REPORT

BatchID: 164432

Sample ID: MB-164432	Client ID:				Units: mg/L		Prep Date: 07/30/2012		Run No: 226009
SampleType: MBLK	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 164432		Analysis Date: 07/30/2012		Seq No: 4730791
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	BRL	0.00400	0	0	0	0	0	0	0	0	

Sample ID: LCS-164432	Client ID:				Units: mg/L		Prep Date: 07/30/2012		Run No: 226009
SampleType: LCS	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 164432		Analysis Date: 07/30/2012		Seq No: 4730792
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.03686	0.00400	0.04	0	92.1	80	120	0	0	0	

Sample ID: 1207I13-001AMS	Client ID:				Units: mg/L		Prep Date: 07/30/2012		Run No: 226009
SampleType: MS	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 164432		Analysis Date: 07/30/2012		Seq No: 4730794
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.03597	0.00400	0.04	0	89.9	80	120	0	0	0	

Sample ID: 1207I13-001AMSD	Client ID:				Units: mg/L		Prep Date: 07/30/2012		Run No: 226009
SampleType: MSD	TestCode: MERCURY, TCLP SW1311/7470A				BatchID: 164432		Analysis Date: 07/30/2012		Seq No: 4730795
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.03638	0.00400	0.04	0	90.9	80	120	0.03597	1.12	20	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Analytical Environmental Services, Inc

Date: 1-Aug-12

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization
Workorder: 1207K20

ANALYTICAL QC SUMMARY REPORT

BatchID: 164522

Sample ID: MB-164522 Client ID:
SampleType: MBLK TestCode: ICP METALS, TCLP SW1311/6010C
Units: mg/L Prep Date: 07/31/2012 Run No: 226053
BatchID: 164522 Analysis Date: 07/31/2012 Seq No: 4732048

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	0.250	0	0	0	0	0	0	0	0	
Barium	BRL	0.500	0	0	0	0	0	0	0	0	
Cadmium	BRL	0.0250	0	0	0	0	0	0	0	0	
Chromium	BRL	0.0500	0	0	0	0	0	0	0	0	
Lead	BRL	0.0500	0	0	0	0	0	0	0	0	
Selenium	BRL	0.100	0	0	0	0	0	0	0	0	
Silver	BRL	0.0250	0	0	0	0	0	0	0	0	

Sample ID: MB-164522-2 Client ID:
SampleType: MBLK TestCode: ICP METALS, TCLP SW1311/6010C
Units: mg/L Prep Date: 07/31/2012 Run No: 226053
BatchID: 164522 Analysis Date: 07/31/2012 Seq No: 4732050

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	0.250	0	0	0	0	0	0	0	0	
Barium	BRL	0.500	0	0	0	0	0	0	0	0	
Cadmium	BRL	0.0250	0	0	0	0	0	0	0	0	
Chromium	BRL	0.0500	0	0	0	0	0	0	0	0	
Lead	BRL	0.0500	0	0	0	0	0	0	0	0	
Selenium	BRL	0.100	0	0	0	0	0	0	0	0	
Silver	BRL	0.0250	0	0	0	0	0	0	0	0	

Sample ID: LCS-164522 Client ID:
SampleType: LCS TestCode: ICP METALS, TCLP SW1311/6010C
Units: mg/L Prep Date: 07/31/2012 Run No: 226053
BatchID: 164522 Analysis Date: 07/31/2012 Seq No: 4732047

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.330	0.250	5	0	107	85	115	0	0	0	
Barium	4.941	0.500	5	0	98.8	80	120	0	0	0	
Cadmium	5.161	0.0250	5	0	103	85	115	0	0	0	
Chromium	5.216	0.0500	5	0	104	85	115	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization
Workorder: 1207K20

ANALYTICAL QC SUMMARY REPORT

BatchID: 164522

Sample ID: LCS-164522 Client ID: Units: mg/L Prep Date: 07/31/2012 Run No: 226053
SampleType: LCS TestCode: ICP METALS, TCLP SW1311/6010C BatchID: 164522 Analysis Date: 07/31/2012 Seq No: 4732047

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	4.969	0.0500	5	0	99.4	85	115	0	0	0	
Selenium	5.408	0.100	5	0	108	85	115	0	0	0	
Silver	0.5020	0.0250	0.5	0	100	85	115	0	0	0	

Sample ID: 1207K20-001AMS Client ID: TP-1@2.5/ TP-2@1/ TP-2@6 Units: mg/L Prep Date: 07/31/2012 Run No: 226053
SampleType: MS TestCode: ICP METALS, TCLP SW1311/6010C BatchID: 164522 Analysis Date: 07/31/2012 Seq No: 4732052

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.344	0.250	5	0	107	50	150	0	0	0	
Barium	6.619	0.500	5	1.672	98.9	50	150	0	0	0	
Cadmium	5.130	0.0250	5	0.01258	102	50	150	0	0	0	
Chromium	5.157	0.0500	5	0	103	50	150	0	0	0	
Lead	6.700	0.0500	5	1.698	100	50	150	0	0	0	
Selenium	5.423	0.100	5	0	108	50	150	0	0	0	
Silver	0.5019	0.0250	0.5	0	100	50	150	0	0	0	

Sample ID: 1207K20-001AMSD Client ID: TP-1@2.5/ TP-2@1/ TP-2@6 Units: mg/L Prep Date: 07/31/2012 Run No: 226053
SampleType: MSD TestCode: ICP METALS, TCLP SW1311/6010C BatchID: 164522 Analysis Date: 07/31/2012 Seq No: 4732054

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.335	0.250	5	0	107	50	150	5.344	0.168	30	
Barium	6.619	0.500	5	1.672	98.9	50	150	6.619	0.005	30	
Cadmium	5.128	0.0250	5	0.01258	102	50	150	5.130	0.045	30	
Chromium	5.121	0.0500	5	0	102	50	150	5.157	0.684	30	
Lead	6.698	0.0500	5	1.698	100	50	150	6.700	0.036	30	
Selenium	5.416	0.100	5	0	108	50	150	5.423	0.121	30	
Silver	0.4996	0.0250	0.5	0	99.9	50	150	0.5019	0.449	30	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

AES

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

July 30, 2012

Britt Bickerstaff
United Consulting Group Inc.
625 Holcomb Bridge Rd
Norcross GA 30071

TEL: (770) 582-2788
FAX: (770) 582-2900

RE: Liddell Drive Equalization Project

Dear Britt Bickerstaff: Order No: 1207F94

Analytical Environmental Services, Inc. received 3 samples on July 24, 2012 1:40 pm for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the analyses contained herein will be noted and submitted in the form of a project Case Narrative.
AES' certifications are as follows:
-NELAC/Florida Certification number E87582 for analysis of Environmental Water, soil/hazardous waste, and Drinking Water Microbiology, effective 07/01/12-06/30/13.
-AIHA Certification ID #100671 for Industrial Hygiene samples (Organics, Inorganics), Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) effective until 09/01/13.

These results relate only to the items tested. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Kathryn F. Waters

Kathryn Waters
Project Manager

3785 PRESIDENTIAL PARKWAY • ATLANTA, GEORGIA 30340 • TEL: (770) 457-8177 • FAX: (770)457-8188

ANALYTICAL ENVIRONMENTAL SERVICES, INC
3785 Presidential Parkway, Atlanta GA 30340-3704
AES TEL.: (770) 457-8177 / TOLL-FREE (800) 972-4889 / FAX: (770) 457-8188

CHAIN OF CUSTODY

Work Order: 1207F94

Date: 7/24/12 Page 1 of 1

COMPANY: United Consulting
ADDRESS: 625 Holcomb Br. Rd Norcross GA 30071
PHONE: 678-410-8474
FAX:
SAMPLED BY: Britt Bickerstaff
SIGNATURE: Britt Bickerstaff

#	SAMPLE ID	SAMPLED DATE	SAMPLED TIME	Grab	Composite	Matrix (See codes)	VOC's	SVOC's	RCRA tot.	RCRA diss.	REMARKS	No. # of Containers
							PRESERVATION (See codes)					
1	LD-B8	7/24/12	12:50p	X		GW	X	X	X	X		6
2	LD-A	7/24/12	12:50p	X		GW	X					2
3	Trip Blank	7/24/12				W	X					2
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												

Visit our website www.aesatlanta.com to check on the status of your results, place bottle orders, etc.

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
1: Britt Bickerstaff	7/24/12 1:40p	1: [signature]	7/24/12 1:40
2:		2:	
3:		3:	

PROJECT INFORMATION
PROJECT NAME: Liddell Drive Equalization Project
PROJECT #: 2012 3542.01
SITE ADDRESS: Liddell Drive, Atlanta GA
SEND REPORT TO: Britt Bickerstaff
INVOICE TO: (IF DIFFERENT FROM ABOVE)
QUOTE #: PO#:

RECEIPT
Total # of Containers: 10

Turnaround Time Request
- ○ Standard 5 Business Days
- ○ 2 Business Day Rush
- ⊗ Next Business Day Rush
- ○ Same Day Rush (auth req.)
- ○ Other

STATE PROGRAM (if any):
E-mail? Y / N; Fax? Y / N
DATA PACKAGE: I II III IV

SPECIAL INSTRUCTIONS/COMMENTS:

SHIPMENT METHOD
OUT / / VIA:
IN / / VIA:
CLIENT FedEx UPS MAIL COURIER
GREYHOUND OTHER

SAMPLES RECEIVED AFTER 3PM OR ON SATURDAY ARE CONSIDERED RECEIVED THE NEXT BUSINESS DAY. IF TURNAROUND TIME IS NOT INDICATED, AES WILL PROCEED WITH STANDARD TAT OF SAMPLES.
SAMPLES ARE DISPOSED 30 DAYS AFTER REPORT COMPLETION UNLESS OTHER ARRANGEMENTS ARE MADE.

MATRIX CODES: A = Air GW = Groundwater SE = Sediment SO = Soil SW = Surface Water W = Water (Blanks) DW = Drinking Water (Blanks) O = Other (specify) WW = Waste Water
PRESERVATIVE CODES: H+I = Hydrochloric acid + ice I = Ice only N = Nitric acid S+I = Sulfuric acid + ice S/M+I = Sodium Bisulfate/Methanol + ice O = Other (specify) NA = None

White Copy - Original; Yellow Copy - Client

Analytical Environmental Services, Inc

Date: 30-Jul-12

Client:	United Consulting Group Inc.
Project:	Liddell Drive Equalization Project
Lab ID:	1207F94

Case Narrative

Semi-Volatile Organics Analysis by Method 8270D:

Phenol values for the QC samples 1207D55-016CMS/MSD are "E" qualified indicating estimated values over linear calibration range due to the level of target analyte present in the unspiked sample.

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	LD-B8
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012 12:50:00 PM
Lab ID:	1207F94-001	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D					(SW3510C)			
1,1'-Biphenyl	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2,4,5-Trichlorophenol	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
2,4,6-Trichlorophenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2,4-Dichlorophenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2,4-Dimethylphenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2,4-Dinitrophenol	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
2,4-Dinitrotoluene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2,6-Dinitrotoluene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2-Chloronaphthalene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2-Chlorophenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2-Methylnaphthalene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2-Methylphenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
2-Nitroaniline	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
2-Nitrophenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
3,3'-Dichlorobenzidine	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
3-Nitroaniline	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
4,6-Dinitro-2-methylphenol	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
4-Bromophenyl phenyl ether	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
4-Chloro-3-methylphenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
4-Chloroaniline	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
4-Chlorophenyl phenyl ether	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
4-Methylphenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
4-Nitroaniline	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
4-Nitrophenol	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
Acenaphthene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Acenaphthylene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Acetophenone	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Anthracene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Atrazine	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Benz(a)anthracene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Benzaldehyde	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Benzo(a)pyrene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Benzo(b)fluoranthene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Benzo(g,h,i)perylene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Benzo(k)fluoranthene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Bis(2-chloroethoxy)methane	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Bis(2-chloroethyl)ether	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Bis(2-chloroisopropyl)ether	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Bis(2-ethylhexyl)phthalate	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Butyl benzyl phthalate	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Caprolactam	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH

Qualifiers:

- * Value exceeds maximum contaminant level
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- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	LD-B8
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012 12:50:00 PM
Lab ID:	1207F94-001	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3510C)				
Carbazole	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Chrysene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Di-n-butyl phthalate	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Di-n-octyl phthalate	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Dibenz(a,h)anthracene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Dibenzofuran	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Diethyl phthalate	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Dimethyl phthalate	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Fluoranthene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Fluorene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Hexachlorobenzene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Hexachlorobutadiene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Hexachlorocyclopentadiene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Hexachloroethane	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Indeno(1,2,3-cd)pyrene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Isophorone	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
N-Nitrosodi-n-propylamine	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
N-Nitrosodiphenylamine	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Naphthalene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Nitrobenzene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Pentachlorophenol	BRL	25		ug/L	164270	1	07/25/2012 14:20	YH
Phenanthrene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Phenol	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Pyrene	BRL	10		ug/L	164270	1	07/25/2012 14:20	YH
Surr: 2,4,6-Tribromophenol	102	47.4-146		%REC	164270	1	07/25/2012 14:20	YH
Surr: 2-Fluorobiphenyl	95.2	51.5-122		%REC	164270	1	07/25/2012 14:20	YH
Surr: 2-Fluorophenol	62.4	28.5-120		%REC	164270	1	07/25/2012 14:20	YH
Surr: 4-Terphenyl-d14	112	47.7-133		%REC	164270	1	07/25/2012 14:20	YH
Surr: Nitrobenzene-d5	82.6	45.7-120		%REC	164270	1	07/25/2012 14:20	YH
Surr: Phenol-d5	43.8	10.9-120		%REC	164270	1	07/25/2012 14:20	YH
TCL VOLATILE ORGANICS SW8260B				(SW5030B)				
1,1,1-Trichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,1,2,2-Tetrachloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,1,2-Trichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,1-Dichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,1-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,2,4-Trichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,2-Dibromo-3-chloropropane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,2-Dibromoethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,2-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
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- N Analyte not NELAC certified
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- > Greater than Result value
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- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	LD-B8
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012 12:50:00 PM
Lab ID:	1207F94-001	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5030B)				
1,2-Dichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,2-Dichloropropane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,3-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
1,4-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
2-Butanone	BRL	50		ug/L	164240	1	07/24/2012 18:21	NP
2-Hexanone	BRL	10		ug/L	164240	1	07/24/2012 18:21	NP
4-Methyl-2-pentanone	BRL	10		ug/L	164240	1	07/24/2012 18:21	NP
Acetone	BRL	50		ug/L	164240	1	07/24/2012 18:21	NP
Benzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Bromodichloromethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Bromoform	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Bromomethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Carbon disulfide	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Carbon tetrachloride	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Chlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Chloroethane	BRL	10		ug/L	164240	1	07/24/2012 18:21	NP
Chloroform	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Chloromethane	BRL	10		ug/L	164240	1	07/24/2012 18:21	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
cis-1,3-Dichloropropene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Cyclohexane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Dibromochloromethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Dichlorodifluoromethane	BRL	10		ug/L	164240	1	07/24/2012 18:21	NP
Ethylbenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Freon-113	BRL	10		ug/L	164240	1	07/24/2012 18:21	NP
Isopropylbenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
m,p-Xylene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Methyl acetate	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Methyl tert-butyl ether	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Methylcyclohexane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Methylene chloride	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
o-Xylene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Styrene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Tetrachloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Toluene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
trans-1,3-Dichloropropene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Trichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Trichlorofluoromethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:21	NP
Vinyl chloride	BRL	2.0		ug/L	164240	1	07/24/2012 18:21	NP
Surr: 4-Bromofluorobenzene	81.1	67.4-123		%REC	164240	1	07/24/2012 18:21	NP

Qualifiers:

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- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	LD-B8
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012 12:50:00 PM
Lab ID:	1207F94-001	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B					(SW5030B)			
Surr: Dibromofluoromethane	114	75.5-128		%REC	164240	1	07/24/2012 18:21	NP
Surr: Toluene-d8	93.6	70-120		%REC	164240	1	07/24/2012 18:21	NP
METALS, DISSOLVED SW6010C					(SW3005A)			
Arsenic	BRL	0.0500		mg/L	164247	1	07/25/2012 10:22	MR
Barium	0.0347	0.0200		mg/L	164247	1	07/25/2012 10:22	MR
Cadmium	BRL	0.0050		mg/L	164247	1	07/25/2012 10:22	MR
Chromium	BRL	0.0100		mg/L	164247	1	07/25/2012 10:22	MR
Lead	BRL	0.0100		mg/L	164247	1	07/25/2012 10:22	MR
Selenium	BRL	0.0200		mg/L	164247	1	07/25/2012 10:22	MR
Silver	BRL	0.0100		mg/L	164247	1	07/25/2012 10:22	MR
Mercury, Total SW7470A					(SW7470A)			
Mercury	BRL	0.00020		mg/L	164234	1	07/25/2012 13:50	LD
Mercury, Dissolved SW7470A					(SW7470A)			
Mercury	BRL	0.00020		mg/L	164207	1	07/25/2012 12:53	LD
METALS, TOTAL SW6010C					(SW3010A)			
Arsenic	BRL	0.0500		mg/L	164193	1	07/25/2012 13:38	MR
Barium	0.0433	0.0200		mg/L	164193	1	07/25/2012 13:38	MR
Cadmium	BRL	0.0050		mg/L	164193	1	07/25/2012 13:38	MR
Chromium	BRL	0.0100		mg/L	164193	1	07/25/2012 13:38	MR
Lead	BRL	0.0100		mg/L	164193	1	07/25/2012 13:38	MR
Selenium	BRL	0.0200		mg/L	164193	1	07/25/2012 13:38	MR
Silver	BRL	0.0100		mg/L	164193	1	07/25/2012 13:38	MR

Qualifiers:

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- NAR See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	LD-A
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012 12:50:00 PM
Lab ID:	1207F94-002	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5030B)				
1,1,1-Trichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,1,2,2-Tetrachloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,1,2-Trichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,1-Dichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,1-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,2,4-Trichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,2-Dibromo-3-chloropropane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,2-Dibromoethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,2-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,2-Dichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,2-Dichloropropane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,3-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
1,4-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
2-Butanone	BRL	50		ug/L	164240	1	07/24/2012 18:50	NP
2-Hexanone	BRL	10		ug/L	164240	1	07/24/2012 18:50	NP
4-Methyl-2-pentanone	BRL	10		ug/L	164240	1	07/24/2012 18:50	NP
Acetone	BRL	50		ug/L	164240	1	07/24/2012 18:50	NP
Benzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Bromodichloromethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Bromoform	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Bromomethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Carbon disulfide	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Carbon tetrachloride	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Chlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Chloroethane	BRL	10		ug/L	164240	1	07/24/2012 18:50	NP
Chloroform	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Chloromethane	BRL	10		ug/L	164240	1	07/24/2012 18:50	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
cis-1,3-Dichloropropene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Cyclohexane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Dibromochloromethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Dichlorodifluoromethane	BRL	10		ug/L	164240	1	07/24/2012 18:50	NP
Ethylbenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Freon-113	BRL	10		ug/L	164240	1	07/24/2012 18:50	NP
Isopropylbenzene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
m,p-Xylene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Methyl acetate	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Methyl tert-butyl ether	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Methylcyclohexane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Methylene chloride	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
o-Xylene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
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- N Analyte not NELAC certified
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- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	LD-A
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012 12:50:00 PM
Lab ID:	1207F94-002	**Matrix:**	Groundwater

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
Styrene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Tetrachloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Toluene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
trans-1,3-Dichloropropene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Trichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Trichlorofluoromethane	BRL	5.0		ug/L	164240	1	07/24/2012 18:50	NP
Vinyl chloride	BRL	2.0		ug/L	164240	1	07/24/2012 18:50	NP
Surr: 4-Bromofluorobenzene	80.3	67.4-123		%REC	164240	1	07/24/2012 18:50	NP
Surr: Dibromofluoromethane	123	75.5-128		%REC	164240	1	07/24/2012 18:50	NP
Surr: Toluene-d8	91.4	70-120		%REC	164240	1	07/24/2012 18:50	NP

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TRIP BLANK
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012
Lab ID:	1207F94-003	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
1,1,1-Trichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,1,2,2-Tetrachloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,1,2-Trichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,1-Dichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,1-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,2,4-Trichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,2-Dibromo-3-chloropropane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,2-Dibromoethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,2-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,2-Dichloroethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,2-Dichloropropane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,3-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
1,4-Dichlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
2-Butanone	BRL	50		ug/L	164240	1	07/24/2012 17:52	NP
2-Hexanone	BRL	10		ug/L	164240	1	07/24/2012 17:52	NP
4-Methyl-2-pentanone	BRL	10		ug/L	164240	1	07/24/2012 17:52	NP
Acetone	BRL	50		ug/L	164240	1	07/24/2012 17:52	NP
Benzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Bromodichloromethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Bromoform	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Bromomethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Carbon disulfide	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Carbon tetrachloride	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Chlorobenzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Chloroethane	BRL	10		ug/L	164240	1	07/24/2012 17:52	NP
Chloroform	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Chloromethane	BRL	10		ug/L	164240	1	07/24/2012 17:52	NP
cis-1,2-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
cis-1,3-Dichloropropene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Cyclohexane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Dibromochloromethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Dichlorodifluoromethane	BRL	10		ug/L	164240	1	07/24/2012 17:52	NP
Ethylbenzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Freon-113	BRL	10		ug/L	164240	1	07/24/2012 17:52	NP
Isopropylbenzene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
m,p-Xylene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Methyl acetate	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Methyl tert-butyl ether	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Methylcyclohexane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Methylene chloride	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
o-Xylene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 30-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TRIP BLANK
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/24/2012
Lab ID:	1207F94-003	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5030B)				
Styrene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Tetrachloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Toluene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
trans-1,2-Dichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
trans-1,3-Dichloropropene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Trichloroethene	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Trichlorofluoromethane	BRL	5.0		ug/L	164240	1	07/24/2012 17:52	NP
Vinyl chloride	BRL	2.0		ug/L	164240	1	07/24/2012 17:52	NP
Surr: 4-Bromofluorobenzene	86.1	67.4-123		%REC	164240	1	07/24/2012 17:52	NP
Surr: Dibromofluoromethane	112	75.5-128		%REC	164240	1	07/24/2012 17:52	NP
Surr: Toluene-d8	94	70-120		%REC	164240	1	07/24/2012 17:52	NP

Qualifiers:

- `*` Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- `>` Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- `<` Less than Result value
- J Estimated value detected below Reporting Limit

Client: United Consulting Group Inc.
Project: Liddell Drive Equalization Project
Lab Order: 1207F94

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
1207F94-001A	LD-B8	7/24/2012 12:50:00PM	Groundwater	TCL VOLATILE ORGANICS		07/24/2012	07/24/2012
1207F94-001B	LD-B8	7/24/2012 12:50:00PM	Groundwater	TOTAL METALS BY ICP		07/24/2012	07/25/2012
1207F94-001B	LD-B8	7/24/2012 12:50:00PM	Groundwater	TOTAL MERCURY		07/24/2012	07/25/2012
1207F94-001C	LD-B8	7/24/2012 12:50:00PM	Groundwater	DISSOLVED METALS BY ICP		07/24/2012	07/25/2012
1207F94-001C	LD-B8	7/24/2012 12:50:00PM	Groundwater	MERCURY, DISSOLVED		07/24/2012	07/25/2012
1207F94-001D	LD-B8	7/24/2012 12:50:00PM	Groundwater	TCL-SEMIVOLATILE ORGANICS		07/25/2012	07/25/2012
1207F94-002A	LD-A	7/24/2012 12:50:00PM	Groundwater	TCL VOLATILE ORGANICS		07/24/2012	07/24/2012
1207F94-003A	TRIP BLANK	7/24/2012 12:00:00AM	Aqueous	TCL VOLATILE ORGANICS		07/24/2012	07/24/2012

Analytical Environmental Services, Inc

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

Date: 30-Jul-12

ANALYTICAL QC SUMMARY REPORT

BatchID: 164193

Sample ID: MB-164193 Client ID:
SampleType: MBLK TestCode: METALS, TOTAL SW6010C
Units: mg/L Prep Date: 07/24/2012 Run No: 225725
BatchID: 164193 Analysis Date: 07/25/2012 Seq No: 4724776

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	0.0500	0	0	0	0	0	0	0	0	
Barium	BRL	0.0200	0	0	0	0	0	0	0	0	
Cadmium	BRL	0.0050	0	0	0	0	0	0	0	0	
Chromium	BRL	0.0100	0	0	0	0	0	0	0	0	
Lead	BRL	0.0100	0	0	0	0	0	0	0	0	
Selenium	BRL	0.0200	0	0	0	0	0	0	0	0	
Silver	BRL	0.0100	0	0	0	0	0	0	0	0	

Sample ID: LCS-164193 Client ID:
SampleType: LCS TestCode: METALS, TOTAL SW6010C
Units: mg/L Prep Date: 07/24/2012 Run No: 225725
BatchID: 164193 Analysis Date: 07/25/2012 Seq No: 4724775

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	1.104	0.0500	1	0	110	80	120	0	0	0	
Barium	1.025	0.0200	1	0	103	80	120	0	0	0	
Cadmium	1.062	0.0050	1	0	106	80	120	0	0	0	
Chromium	1.067	0.0100	1	0	107	80	120	0	0	0	
Lead	1.063	0.0100	1	0	106	80	120	0	0	0	
Selenium	1.126	0.0200	1	0	113	80	120	0	0	0	
Silver	0.1036	0.0100	0.1	0	104	80	120	0	0	0	

Sample ID: 1207F94-001BMS Client ID: LD-B8
SampleType: MS TestCode: METALS, TOTAL SW6010C
Units: mg/L Prep Date: 07/24/2012 Run No: 225725
BatchID: 164193 Analysis Date: 07/25/2012 Seq No: 4724778

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	1.076	0.0500	1	0	108	75	125	0	0	0	
Barium	1.003	0.0200	1	0.04332	96	75	125	0	0	0	
Cadmium	1.013	0.0050	1	0	101	75	125	0	0	0	
Chromium	1.053	0.0100	1	0.004328	105	75	125	0	0	0	

Qualifiers:

- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

ANALYTICAL QC SUMMARY REPORT

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

BatchID: 164193

Sample ID: 1207F94-001BMS Client ID: LD-B8 Units: mg/L Prep Date: 07/24/2012 Run No: 225725
SampleType: MS TestCode: METALS, TOTAL SW6010C BatchID: 164193 Analysis Date: 07/25/2012 Seq No: 4724778

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	0.9810	0.0100	1	0	98.1	75	125	0	0	0	
Selenium	1.088	0.0200	1	0.006166	108	75	125	0	0	0	
Silver	0.09984	0.0100	0.1	0	99.8	75	125	0	0	0	

Sample ID: 1207F94-001BMSD Client ID: LD-B8 Units: mg/L Prep Date: 07/24/2012 Run No: 225725
SampleType: MSD TestCode: METALS, TOTAL SW6010C BatchID: 164193 Analysis Date: 07/25/2012 Seq No: 4724779

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	1.084	0.0500	1	0	108	75	125	1.076	0.669	20	
Barium	1.008	0.0200	1	0.04332	96.5	75	125	1.003	0.544	20	
Cadmium	1.019	0.0050	1	0	102	75	125	1.013	0.605	20	
Chromium	1.061	0.0100	1	0.004328	106	75	125	1.053	0.783	20	
Lead	0.9862	0.0100	1	0	98.6	75	125	0.9810	0.52	20	
Selenium	1.099	0.0200	1	0.006166	109	75	125	1.088	1.01	20	
Silver	0.1007	0.0100	0.1	0	101	75	125	0.09984	0.825	20	

Qualifiers:

>	Greater than Result value	«	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

Date: 30-Jul-12

ANALYTICAL QC SUMMARY REPORT

BatchID: 164207

Sample ID: **MB-164207** Client ID:
SampleType: **MBLK** TestCode: **Mercury, Dissolved SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225664**
BatchID: **164207** Analysis Date: **07/24/2012** Seq No: **4723305**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	BRL	0.00020	0	0	0	0	0	0	0	0	

Sample ID: **LCS-164207** Client ID:
SampleType: **LCS** TestCode: **Mercury, Dissolved SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225664**
BatchID: **164207** Analysis Date: **07/24/2012** Seq No: **4723308**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.004701	0.00020	0.005	0	94	85	115	0	0	0	

Sample ID: **1207C21-002DMS** Client ID:
SampleType: **MS** TestCode: **Mercury, Dissolved SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225664**
BatchID: **164207** Analysis Date: **07/24/2012** Seq No: **4723316**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.004465	0.00020	0.005	0	89.3	70	130	0	0	0	

Sample ID: **1207C21-002DMSD** Client ID:
SampleType: **MSD** TestCode: **Mercury, Dissolved SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225664**
BatchID: **164207** Analysis Date: **07/24/2012** Seq No: **4723319**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.004448	0.00020	0.005	0	89	70	130	0.004465	0.378	20	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Analytical Environmental Services, Inc

ANALYTICAL QC SUMMARY REPORT

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

BatchID: 164234

Sample ID: **MB-164234** Client ID:
SampleType: **MBLK** TestCode: **Mercury, Total SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225740**
BatchID: **164234** Analysis Date: **07/25/2012** Seq No: **4725120**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	BRL	0.00020	0	0	0	0	0	0	0	0	

Sample ID: **LCS-164234** Client ID:
SampleType: **LCS** TestCode: **Mercury, Total SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225740**
BatchID: **164234** Analysis Date: **07/25/2012** Seq No: **4725122**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.005360	0.00020	0.005	0	107	85	115	0	0	0	

Sample ID: **1207C84-003AMS** Client ID:
SampleType: **MS** TestCode: **Mercury, Total SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225740**
BatchID: **164234** Analysis Date: **07/25/2012** Seq No: **4725126**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.005358	0.00020	0.005	0	107	70	130	0	0	0	

Sample ID: **1207C84-003AMSD** Client ID:
SampleType: **MSD** TestCode: **Mercury, Total SW7470A**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225740**
BatchID: **164234** Analysis Date: **07/25/2012** Seq No: **4725128**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.005362	0.00020	0.005	0	107	70	130	0.005358	0.082	20	

Qualifiers:

>	Greater than Result value	<	Less than Result value
BRL	Below reporting limit	E	Estimated (value above quantitation range)
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix

B	Analyte detected in the associated method blank
H	Holding times for preparation or analysis exceeded
R	RPD outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164240

Sample ID: MB-164240 Client ID:
SampleType: MBLK TestCode: TCL VOLATILE ORGANICS SW8260B
Units: ug/L BatchID: 164240
Prep Date: 07/24/2012 Analysis Date: 07/24/2012
Run No: 225686 Seq No: 4724000

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2,2-Tetrachloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2,4-Trichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromo-3-chloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromoethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,3-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,4-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
2-Butanone	BRL	50	0	0	0	0	0	0	0	0	
2-Hexanone	BRL	10	0	0	0	0	0	0	0	0	
4-Methyl-2-pentanone	BRL	10	0	0	0	0	0	0	0	0	
Acetone	BRL	50	0	0	0	0	0	0	0	0	
Benzene	BRL	5.0	0	0	0	0	0	0	0	0	
Bromodichloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Bromoform	BRL	5.0	0	0	0	0	0	0	0	0	
Bromomethane	BRL	5.0	0	0	0	0	0	0	0	0	
Carbon disulfide	BRL	5.0	0	0	0	0	0	0	0	0	
Carbon tetrachloride	BRL	5.0	0	0	0	0	0	0	0	0	
Chlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Chloroethane	BRL	10	0	0	0	0	0	0	0	0	
Chloroform	BRL	5.0	0	0	0	0	0	0	0	0	
Chloromethane	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164240

Sample ID: MB-164240 Client ID: Units: ug/L Prep Date: 07/24/2012 Run No: 225686
SampleType: MBLK TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164240 Analysis Date: 07/24/2012 Seq No: 4724000

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
cis-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
cis-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Cyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Dibromochloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Dichlorodifluoromethane	BRL	10	0	0	0	0	0	0	0	0	
Ethylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Freon-113	BRL	10	0	0	0	0	0	0	0	0	
Isopropylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
m,p-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl acetate	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl tert-butyl ether	BRL	5.0	0	0	0	0	0	0	0	0	
Methylcyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Methylene chloride	BRL	5.0	0	0	0	0	0	0	0	0	
o-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Styrene	BRL	5.0	0	0	0	0	0	0	0	0	
Tetrachloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Toluene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichlorofluoromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Vinyl chloride	BRL	2.0	0	0	0	0	0	0	0	0	
Surr: 4-Bromofluorobenzene	43.07	0	50	0	86.1	67.4	123	0	0	0	
Surr: Dibromofluoromethane	51.77	0	50	0	104	75.5	128	0	0	0	
Surr: Toluene-d8	44.54	0	50	0	89.1	70	120	0	0	0	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164240

Sample ID: LCS-164240	Client ID:	Units: ug/L	Prep Date: 07/24/2012	Run No: 225686
SampleType: LCS	TestCode: TCL VOLATILE ORGANICS SW8260B	BatchID: 164240	Analysis Date: 07/24/2012	Seq No: 4723985

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	60.63	5.0	50	0	121	60	140	0	0	0	
Benzene	58.26	5.0	50	0	117	70	130	0	0	0	
Chlorobenzene	49.99	5.0	50	0	100	70	130	0	0	0	
Toluene	55.55	5.0	50	0	111	70	130	0	0	0	
Trichloroethene	47.04	5.0	50	0	94.1	70	130	0	0	0	
Surr: 4-Bromofluorobenzene	54.36	0	50	0	109	67.4	123	0	0	0	
Surr: Dibromofluoromethane	55.40	0	50	0	111	75.5	128	0	0	0	
Surr: Toluene-d8	48.80	0	50	0	97.6	70	120	0	0	0	

Sample ID: 1207E25-018AMS	Client ID:	Units: ug/L	Prep Date: 07/24/2012	Run No: 225686
SampleType: MS	TestCode: TCL VOLATILE ORGANICS SW8260B	BatchID: 164240	Analysis Date: 07/24/2012	Seq No: 4723989

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	669.1	50	500	17.20	130	50.1	179	0	0	0	
Benzene	597.4	50	500	0	119	61.2	150	0	0	0	
Chlorobenzene	513.9	50	500	0	103	72.1	140	0	0	0	
Toluene	569.2	50	500	0	114	58.7	154	0	0	0	
Trichloroethene	825.8	50	500	320.2	101	68.3	149	0	0	0	
Surr: 4-Bromofluorobenzene	556.2	0	500	0	111	67.4	123	0	0	0	
Surr: Dibromofluoromethane	538.3	0	500	0	108	75.5	128	0	0	0	
Surr: Toluene-d8	511.9	0	500	0	102	70	120	0	0	0	

Sample ID: 1207E25-018AMSD	Client ID:	Units: ug/L	Prep Date: 07/24/2012	Run No: 225686
SampleType: MSD	TestCode: TCL VOLATILE ORGANICS SW8260B	BatchID: 164240	Analysis Date: 07/24/2012	Seq No: 4723993

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	703.7	50	500	17.20	137	50.1	179	669.1	5.04	23.3	
Benzene	588.9	50	500	0	118	61.2	150	597.4	1.43	19	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164240

Sample ID: 1207E25-018AMSD	Client ID:	Units: ug/L	Prep Date: 07/24/2012	Run No: 225686
SampleType: MSD	TestCode: TCL VOLATILE ORGANICS SW8260B	BatchID: 164240	Analysis Date: 07/24/2012	Seq No: 4723993

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Chlorobenzene	512.6	50	500	0	103	72.1	140	513.9	0.253	21.5	
Toluene	553.3	50	500	0	111	58.7	154	569.2	2.83	20	
Trichloroethene	831.3	50	500	320.2	102	68.3	149	825.8	0.664	17.7	
Surr: 4-Bromofluorobenzene	540.9	0	500	0	108	67.4	123	556.2	0	0	
Surr: Dibromofluoromethane	521.4	0	500	0	104	75.5	128	538.3	0	0	
Surr: Toluene-d8	487.0	0	500	0	97.4	70	120	511.9	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164247

Sample ID: **MB-164247** Client ID:
SampleType: **MBLK** TestCode: **METALS, DISSOLVED SW6010C**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225707**
BatchID: **164247** Analysis Date: **07/25/2012** Seq No: **4724473**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	0.0500	0	0	0	0	0	0	0	0	
Barium	BRL	0.0200	0	0	0	0	0	0	0	0	
Cadmium	BRL	0.0050	0	0	0	0	0	0	0	0	
Chromium	BRL	0.0100	0	0	0	0	0	0	0	0	
Lead	BRL	0.0100	0	0	0	0	0	0	0	0	
Selenium	BRL	0.0200	0	0	0	0	0	0	0	0	
Silver	BRL	0.0100	0	0	0	0	0	0	0	0	

Sample ID: **LCS-164247** Client ID:
SampleType: **LCS** TestCode: **METALS, DISSOLVED SW6010C**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225707**
BatchID: **164247** Analysis Date: **07/25/2012** Seq No: **4724472**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	1.012	0.0500	1	0	101	80	120	0	0	0	
Barium	0.9777	0.0200	1	0	97.8	80	120	0	0	0	
Cadmium	1.010	0.0050	1	0	101	80	120	0	0	0	
Chromium	0.9945	0.0100	1	0	99.5	80	120	0	0	0	
Lead	1.004	0.0100	1	0	100	80	120	0	0	0	
Selenium	1.058	0.0200	1	0	106	80	120	0	0	0	
Silver	0.09779	0.0100	0.1	0	97.8	80	120	0	0	0	

Sample ID: **1207F94-001CMS** Client ID: **LD-B8**
SampleType: **MS** TestCode: **METALS, DISSOLVED SW6010C**
Units: **mg/L** Prep Date: **07/24/2012** Run No: **225707**
BatchID: **164247** Analysis Date: **07/25/2012** Seq No: **4724478**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	1.002	0.0500	1	0	100	75	125	0	0	0	
Barium	0.9744	0.0200	1	0.03465	94	75	125	0	0	0	
Cadmium	0.9685	0.0050	1	0	96.9	75	125	0	0	0	
Chromium	0.9894	0.0100	1	0	98.9	75	125	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164247

Sample ID: **1207F94-001CMS** Client ID: **LD-B8** Units: **mg/L** Prep Date: **07/24/2012** Run No: **225707**
SampleType: **MS** TestCode: **METALS, DISSOLVED SW6010C** BatchID: **164247** Analysis Date: **07/25/2012** Seq No: **4724478**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	0.9363	0.0100	1	0	93.6	75	125	0	0	0	
Selenium	1.054	0.0200	1	0	105	75	125	0	0	0	
Silver	0.09519	0.0100	0.1	0	95.2	75	125	0	0	0	

Sample ID: **1207F94-001CMSD** Client ID: **LD-B8** Units: **mg/L** Prep Date: **07/24/2012** Run No: **225707**
SampleType: **MSD** TestCode: **METALS, DISSOLVED SW6010C** BatchID: **164247** Analysis Date: **07/25/2012** Seq No: **4724479**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	1.003	0.0500	1	0	100	75	125	1.002	0.122	20	
Barium	0.9687	0.0200	1	0.03465	93.4	75	125	0.9744	0.595	20	
Cadmium	0.9687	0.0050	1	0	96.9	75	125	0.9685	0.023	20	
Chromium	0.9831	0.0100	1	0	98.3	75	125	0.9894	0.634	20	
Lead	0.9357	0.0100	1	0	93.6	75	125	0.9363	0.056	20	
Selenium	1.054	0.0200	1	0	105	75	125	1.054	0.049	20	
Silver	0.09516	0.0100	0.1	0	95.2	75	125	0.09519	0.024	20	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: MB-164270 Client ID:
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/L Prep Date: 07/25/2012 Run No: 225734
BatchID: 164270 Analysis Date: 07/25/2012 Seq No: 4725015

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1'-Biphenyl	BRL	10	0	0	0	0	0	0	0	0	
2,4,5-Trichlorophenol	BRL	25	0	0	0	0	0	0	0	0	
2,4,6-Trichlorophenol	BRL	10	0	0	0	0	0	0	0	0	
2,4-Dichlorophenol	BRL	10	0	0	0	0	0	0	0	0	
2,4-Dimethylphenol	BRL	10	0	0	0	0	0	0	0	0	
2,4-Dinitrophenol	BRL	25	0	0	0	0	0	0	0	0	
2,4-Dinitrotoluene	BRL	10	0	0	0	0	0	0	0	0	
2,6-Dinitrotoluene	BRL	10	0	0	0	0	0	0	0	0	
2-Chloronaphthalene	BRL	10	0	0	0	0	0	0	0	0	
2-Chlorophenol	BRL	10	0	0	0	0	0	0	0	0	
2-Methylnaphthalene	BRL	10	0	0	0	0	0	0	0	0	
2-Methylphenol	BRL	10	0	0	0	0	0	0	0	0	
2-Nitroaniline	BRL	25	0	0	0	0	0	0	0	0	
2-Nitrophenol	BRL	10	0	0	0	0	0	0	0	0	
3,3'-Dichlorobenzidine	BRL	10	0	0	0	0	0	0	0	0	
3-Nitroaniline	BRL	25	0	0	0	0	0	0	0	0	
4,6-Dinitro-2-methylphenol	BRL	25	0	0	0	0	0	0	0	0	
4-Bromophenyl phenyl ether	BRL	10	0	0	0	0	0	0	0	0	
4-Chloro-3-methylphenol	BRL	10	0	0	0	0	0	0	0	0	
4-Chloroaniline	BRL	10	0	0	0	0	0	0	0	0	
4-Chlorophenyl phenyl ether	BRL	10	0	0	0	0	0	0	0	0	
4-Methylphenol	BRL	10	0	0	0	0	0	0	0	0	
4-Nitroaniline	BRL	25	0	0	0	0	0	0	0	0	
4-Nitrophenol	BRL	25	0	0	0	0	0	0	0	0	
Acenaphthene	BRL	10	0	0	0	0	0	0	0	0	
Acenaphthylene	BRL	10	0	0	0	0	0	0	0	0	
Acetophenone	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: MB-164270 Client ID: Units: ug/L Prep Date: 07/25/2012 Run No: 225734
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D BatchID: 164270 Analysis Date: 07/25/2012 Seq No: 4725015

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Anthracene	BRL	10	0	0	0	0	0	0	0	0	
Atrazine	BRL	10	0	0	0	0	0	0	0	0	
Benz(a)anthracene	BRL	10	0	0	0	0	0	0	0	0	
Benzaldehyde	BRL	10	0	0	0	0	0	0	0	0	
Benzo(a)pyrene	BRL	10	0	0	0	0	0	0	0	0	
Benzo(b)fluoranthene	BRL	10	0	0	0	0	0	0	0	0	
Benzo(g,h,i)perylene	BRL	10	0	0	0	0	0	0	0	0	
Benzo(k)fluoranthene	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-chloroethoxy)methane	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-chloroethyl)ether	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-chloroisopropyl)ether	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-ethylhexyl)phthalate	BRL	10	0	0	0	0	0	0	0	0	
Butyl benzyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Caprolactam	BRL	10	0	0	0	0	0	0	0	0	
Carbazole	BRL	10	0	0	0	0	0	0	0	0	
Chrysene	BRL	10	0	0	0	0	0	0	0	0	
Di-n-butyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Di-n-octyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Dibenz(a,h)anthracene	BRL	10	0	0	0	0	0	0	0	0	
Dibenzofuran	BRL	10	0	0	0	0	0	0	0	0	
Diethyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Dimethyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Fluoranthene	BRL	10	0	0	0	0	0	0	0	0	
Fluorene	BRL	10	0	0	0	0	0	0	0	0	
Hexachlorobenzene	BRL	10	0	0	0	0	0	0	0	0	
Hexachlorobutadiene	BRL	10	0	0	0	0	0	0	0	0	
Hexachlorocyclopentadiene	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: MB-164270 Client ID:
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/L Prep Date: 07/25/2012 Run No: 225734
BatchID: 164270 Analysis Date: 07/25/2012 Seq No: 4725015

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Hexachloroethane	BRL	10	0	0	0	0	0	0	0	0	
Indeno(1,2,3-cd)pyrene	BRL	10	0	0	0	0	0	0	0	0	
Isophorone	BRL	10	0	0	0	0	0	0	0	0	
N-Nitrosodi-n-propylamine	BRL	10	0	0	0	0	0	0	0	0	
N-Nitrosodiphenylamine	BRL	10	0	0	0	0	0	0	0	0	
Naphthalene	BRL	10	0	0	0	0	0	0	0	0	
Nitrobenzene	BRL	10	0	0	0	0	0	0	0	0	
Pentachlorophenol	BRL	25	0	0	0	0	0	0	0	0	
Phenanthrene	BRL	10	0	0	0	0	0	0	0	0	
Phenol	BRL	10	0	0	0	0	0	0	0	0	
Pyrene	BRL	10	0	0	0	0	0	0	0	0	
Surr: 2,4,6-Tribromophenol	96.77	0	100	0	96.8	47.4	146	0	0	0	
Surr: 2-Fluorobiphenyl	46.80	0	50	0	93.6	51.5	122	0	0	0	
Surr: 2-Fluorophenol	67.57	0	100	0	67.6	28.5	120	0	0	0	
Surr: 4-Terphenyl-d14	58.46	0	50	0	117	47.7	133	0	0	0	
Surr: Nitrobenzene-d5	39.99	0	50	0	80	45.7	120	0	0	0	
Surr: Phenol-d5	46.57	0	100	0	46.6	10.9	120	0	0	0	

Sample ID: LCS-164270 Client ID:
SampleType: LCS TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/L Prep Date: 07/25/2012 Run No: 225809
BatchID: 164270 Analysis Date: 07/26/2012 Seq No: 4726740

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	76.69	10	100	0	76.7	68.2	118	0	0	0	
2-Chlorophenol	68.43	10	100	0	68.4	67.9	120	0	0	0	
4-Chloro-3-methylphenol	76.44	10	100	0	76.4	63.1	120	0	0	0	
4-Nitrophenol	31.71	25	100	0	31.7	21	120	0	0	0	
Acenaphthene	72.30	10	100	0	72.3	68.6	120	0	0	0	
N-Nitrosodi-n-propylamine	74.17	10	100	0	74.2	73.6	127	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: LCS-164270 Client ID: Units: ug/L Prep Date: 07/25/2012 Run No: 225809
SampleType: LCS TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D BatchID: 164270 Analysis Date: 07/26/2012 Seq No: 4726740

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Pentachlorophenol	75.30	25	100	0	75.3	55.2	118	0	0	0	
Phenol	37.73	10	100	0	37.7	26.6	120	0	0	0	
Pyrene	82.48	10	100	0	82.5	66.3	131	0	0	0	
Surr: 2,4,6-Tribromophenol	87.90	0	100	0	87.9	47.4	146	0	0	0	
Surr: 2-Fluorobiphenyl	39.36	0	50	0	78.7	51.5	122	0	0	0	
Surr: 2-Fluorophenol	52.53	0	100	0	52.5	28.5	120	0	0	0	
Surr: 4-Terphenyl-d14	50.49	0	50	0	101	47.7	133	0	0	0	
Surr: Nitrobenzene-d5	35.05	0	50	0	70.1	45.7	120	0	0	0	
Surr: Phenol-d5	35.61	0	100	0	35.6	10.9	120	0	0	0	

Sample ID: 1207D55-016CMS Client ID: Units: ug/L Prep Date: 07/25/2012 Run No: 225809
SampleType: MS TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D BatchID: 164270 Analysis Date: 07/26/2012 Seq No: 4728335

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	68.85	50	100	0	68.8	54.4	120	0	0	0	
2-Chlorophenol	74.65	50	100	0	74.6	56.6	120	0	0	0	
4-Chloro-3-methylphenol	BRL	50	100	0	0	49.8	120	0	0	0	S
4-Nitrophenol	BRL	130	100	0	85.8	22	120	0	0	0	
Acenaphthene	401.4	50	100	491.6	-90.1	57.8	120	0	0	0	S
N-Nitrosodi-n-propylamine	BRL	50	100	0	0	60.7	124	0	0	0	S
Pentachlorophenol	160.4	130	100	113.8	46.6	37.6	130	0	0	0	
Phenol	2283	50	100	2390	-107	27.9	120	0	0	0	SE
Pyrene	130.3	50	100	86.05	44.2	57.9	118	0	0	0	S
Surr: 2,4,6-Tribromophenol	80.95	0	100	0	81	47.4	146	0	0	0	
Surr: 2-Fluorobiphenyl	35.10	0	50	0	70.2	51.5	122	0	0	0	
Surr: 2-Fluorophenol	55.60	0	100	0	55.6	28.5	120	0	0	0	
Surr: 4-Terphenyl-d14	47.90	0	50	0	95.8	47.7	133	0	0	0	
Surr: Nitrobenzene-d5	35.95	0	50	0	71.9	45.7	120	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207F94

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: 1207D55-016CMS	Client ID:				Units: ug/L		Prep Date: 07/25/2012		Run No: 225809	
SampleType: MS	TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D				BatchID: 164270		Analysis Date: 07/26/2012		Seq No: 4728335	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Surr: Phenol-d5	58.45	0	100	0	58.4	10.9	120	0	0	0	

Sample ID: 1207D55-016CMSD	Client ID:				Units: ug/L		Prep Date: 07/25/2012		Run No: 225809	
SampleType: MSD	TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D				BatchID: 164270		Analysis Date: 07/26/2012		Seq No: 4728336	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	72.30	50	100	0	72.3	54.4	120	68.85	4.89	25.5	
2-Chlorophenol	75.55	50	100	0	75.6	56.6	120	74.65	1.2	26.2	
4-Chloro-3-methylphenol	90.80	50	100	0	90.8	49.8	120	0	200	62.9	R
4-Nitrophenol	BRL	130	100	0	77.9	22	120	85.80	0	31.4	
Acenaphthene	431.8	50	100	491.6	-59.8	57.8	120	401.4	7.27	24.7	S
N-Nitrosodi-n-propylamine	BRL	50	100	0	0	60.7	124	0	0	28.2	S
Pentachlorophenol	166.8	130	100	113.8	53	37.6	130	160.4	3.91	26.6	
Phenol	2394	50	100	2390	3.75	27.9	120	2283	4.76	29.5	SE
Pyrene	137.0	50	100	86.05	51	57.9	118	130.3	5.01	24.4	S
Surr: 2,4,6-Tribromophenol	83.15	0	100	0	83.2	47.4	146	80.95	0	0	
Surr: 2-Fluorobiphenyl	37.90	0	50	0	75.8	51.5	122	35.10	0	0	
Surr: 2-Fluorophenol	57.95	0	100	0	58	28.5	120	55.60	0	0	
Surr: 4-Terphenyl-d14	49.65	0	50	0	99.3	47.7	133	47.90	0	0	
Surr: Nitrobenzene-d5	37.45	0	50	0	74.9	45.7	120	35.95	0	0	
Surr: Phenol-d5	59.50	0	100	0	59.5	10.9	120	58.45	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

AES

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

July 30, 2012

Britt Bickerstaff
United Consulting Group Inc.
625 Holcomb Bridge Rd
Norcross GA 30071

TEL: (770) 582-2788
FAX: (770) 582-2900

RE: Liddell Drive Equalization Project

Dear Britt Bickerstaff: Order No: 1207H10

Analytical Environmental Services, Inc. received 14 samples on July 25, 2012 5:13 pm for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the analyses contained herein will be noted and submitted in the form of a project Case Narrative.
AES' certifications are as follows:
-NELAC/Florida Certification number E87582 for analysis of Environmental Water, soil/hazardous waste, and Drinking Water Microbiology, effective 07/01/12-06/30/13.
-AIHA Certification ID #100671 for Industrial Hygiene samples (Organics, Inorganics), Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) effective until 09/01/13.

These results relate only to the items tested. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Kathryn F. Waters

Kathryn Waters
Project Manager

3785 PRESIDENTIAL PARKWAY • ATLANTA, GEORGIA 30340 • TEL: (770) 457-8177 • FAX: (770)457-8188

ANALYTICAL ENVIRONMENTAL SERVICES, INC
3785 Presidential Parkway, Atlanta GA 30340-3704
AES TEL.: (770) 457-8177 / TOLL-FREE (800) 972-4889 / FAX: (770) 457-8188

CHAIN OF CUSTODY

Work Order: 1207H10

Date: 7/25/12 Page 1 of 1

COMPANY: United Consulting
ADDRESS: 625 Holcomb Br. Rd, Norcross GA 30071
PHONE: 678-410-8474
FAX:
SAMPLED BY: Britt B.
SIGNATURE: Britt Bul[illegible]

Visit our website **www.aesatlanta.com** to check on the status of your results, place bottle orders, etc.

#	SAMPLE ID	SAMPLED DATE	SAMPLED TIME	Grab	Composite	Matrix (See codes)	RCRA Metals	VOC's	SVOC's	TCLP-RCRA	TCLP VOC's/SVOCs	REMARKS	No # of Containers
1	TP-1 @ 1	7/25/12	8:50a	X		S	X						1
2	TP-1 @ 2.5	7/25/12	9:35	X		S	X	X	X				6
3	TP-2 @ 1	7/25/12	10:05a	X		S	X						1
4	TP-2 @ 6	7/25/12	10:30a	X		S	X	X	X				6
5	TP-3 @ 1	7/25/12	10:55a	X		S	X						1
6	TP-3 @ 3	7/25/12	11:10a	X		S	X	X	X				6
7	TP-4 @ 1	7/25/12	12:05	X		S	X						1
8	TP-4 @ 6	7/25/12	12:30	X		S	X	X	X				6
9	TP-4 @ 2.5	7/25/12	1:40	X		S	X	X	X				6
10	Duplicate	7/25/12	1:40	X		S	X	X	X				6
11	TP-1 to 4	7/[illegible]/12	12:40	[illegible]	X	S				X			1
12	TP-4 @ 2	7/25/12	11:40	X		S					X		1
13	Trip Blank	7/25/12				W		X					2
14	FB		4:00			W			X				1

PRESERVATION (See codes)

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
1: Britt Bul[illegible]	7/25/12 5:13	1: Latoya P	7/25/12 5:13pm
2:		2:	
3:		3:	

PROJECT INFORMATION
PROJECT NAME: Liddell Drive Evaluations Proj.
PROJECT #: 2012-3532.01
SITE ADDRESS: Liddell Drive, Atlanta GA
SEND REPORT TO: Britt Bul[illegible]
INVOICE TO: (IF DIFFERENT FROM ABOVE)
QUOTE #: PO#:

RECEIPT
Total # of Containers: 48

Turnaround Time Request:
- ○ Standard 5 Business Days
- ○ 2 Business Day Rush
- ☒ Next Business Day Rush
- ○ Same Day Rush (auth req.)
- ○ Other

STATE PROGRAM (if any):
E-mail? Y / N, Fax? Y / N
DATA PACKAGE: I II III IV

SPECIAL INSTRUCTIONS/COMMENTS:

SHIPMENT METHOD
OUT / / VIA:
IN / / VIA:
(CLIENT circled) FedEx UPS MAIL COURIER GREYHOUND OTHER

SAMPLES RECEIVED AFTER 3PM OR ON SATURDAY ARE CONSIDERED RECEIVED THE NEXT BUSINESS DAY. IF TURNAROUND TIME IS NOT INDICATED, AES WILL PROCEED WITH STANDARD TAT OF SAMPLES.
SAMPLES ARE DISPOSED 30 DAYS AFTER REPORT COMPLETION UNLESS OTHER ARRANGEMENTS ARE MADE.

MATRIX CODES: A = Air GW = Groundwater SE = Sediment SO = Soil SW = Surface Water W = Water (Blanks) DW = Drinking Water (Blanks) O = Other (specify) WW = Waste Water
PRESERVATIVE CODES: H+I = Hydrochloric acid + ice I = Ice only N = Nitric acid S+I = Sulfuric acid + ice S/M+I = Sodium Bisulfate/Methanol + ice O = Other (specify) NA = None

White Copy - Original; Yellow Copy - Client

Analytical Environmental Services, Inc

Date: 28-Jul-12

Client:	United Consulting Group Inc.
Project:	Liddell Drive Equalization Project
Lab ID:	1207H10

Case Narrative

Per phone instructions from Britt Bickerstaff on 7/26/12 at 10:17 am the VOC and SVOC analysis on sample 1207H10-010 (Duplicate) is cancelled.

Volatile Organic Compounds Analysis by Method 8260B:

Percent recovery for the internal standard compound 1,4-Dichlorobenzene-d4 on sample 1207H10-004A was outside control limits biased low due to suspected matrix interference.

Percent recovery for the internal standard compounds Chlorobenzene-d5 and 1,4-Dichlorobenzene-d4 on sample 1207H10-002A was outside control limits biased low due to suspected matrix interference.

Semi-volatile Organics Analysis by Method 8270D:

LCS-164273 recovery for 4-terpehny-d14 was outside control limits biased high. Target analyte was not detected in the analytical samples and data is reportable with high bias.

Due to sample matrix, samples 1207H10-002C, -004C required dilution during analysis resulting in elevated reporting limits.

Metals Analysis by Method 6010B:

Due to sample matrix, sample 1207H10-002C required dilution during analysis resulting in elevated reporting limits.

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-1@1
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 8:50:00 AM
Lab ID:	1207H10-001	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					**(SW7471B)**			
Mercury	BRL	0.110		mg/Kg-dry	164332	1	07/26/2012 14:38	LD
METALS, TOTAL SW6010C					**(SW3050B)**			
Arsenic	BRL	5.30		mg/Kg-dry	164343	1	07/27/2012 10:50	TA
Barium	75.5	5.30		mg/Kg-dry	164343	1	07/27/2012 10:50	TA
Cadmium	BRL	2.65		mg/Kg-dry	164343	1	07/27/2012 10:50	TA
Chromium	13.2	2.65		mg/Kg-dry	164343	1	07/27/2012 10:50	TA
Lead	154	5.30		mg/Kg-dry	164343	1	07/27/2012 10:50	TA
Selenium	BRL	5.30		mg/Kg-dry	164343	1	07/27/2012 10:50	TA
Silver	BRL	2.65		mg/Kg-dry	164343	1	07/27/2012 10:50	TA
PERCENT MOISTURE D2216								
Percent Moisture	10.5	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-1@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 9:35:00 AM
Lab ID:	1207H10-002	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B				(SW7471B)				
Mercury	0.231	0.152		mg/Kg-dry	164332	1	07/26/2012 14:40	LD
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3550C)				
1,1'-Biphenyl	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2,4,5-Trichlorophenol	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2,4,6-Trichlorophenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2,4-Dichlorophenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2,4-Dimethylphenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2,4-Dinitrophenol	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2,4-Dinitrotoluene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2,6-Dinitrotoluene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2-Chloronaphthalene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2-Chlorophenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2-Methylnaphthalene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2-Methylphenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2-Nitroaniline	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
2-Nitrophenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
3,3'-Dichlorobenzidine	BRL	5100		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
3-Nitroaniline	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4,6-Dinitro-2-methylphenol	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4-Bromophenyl phenyl ether	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4-Chloro-3-methylphenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4-Chloroaniline	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4-Chlorophenyl phenyl ether	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4-Methylphenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4-Nitroaniline	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
4-Nitrophenol	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Acenaphthene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Acenaphthylene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Acetophenone	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Anthracene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Atrazine	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Benz(a)anthracene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Benzaldehyde	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Benzo(a)pyrene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Benzo(b)fluoranthene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Benzo(g,h,i)perylene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Benzo(k)fluoranthene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Bis(2-chloroethoxy)methane	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Bis(2-chloroethyl)ether	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Bis(2-chloroisopropyl)ether	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-1@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 9:35:00 AM
Lab ID:	1207H10-002	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3550C)				
Bis(2-ethylhexyl)phthalate	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Butyl benzyl phthalate	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Caprolactam	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Carbazole	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Chrysene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Di-n-butyl phthalate	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Di-n-octyl phthalate	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Dibenz(a,h)anthracene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Dibenzofuran	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Diethyl phthalate	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Dimethyl phthalate	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Fluoranthene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Fluorene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Hexachlorobenzene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Hexachlorobutadiene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Hexachlorocyclopentadiene	BRL	5000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Hexachloroethane	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Indeno(1,2,3-cd)pyrene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Isophorone	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
N-Nitrosodi-n-propylamine	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
N-Nitrosodiphenylamine	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Naphthalene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Nitrobenzene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Pentachlorophenol	BRL	13000		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Phenanthrene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Phenol	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Pyrene	BRL	2500		ug/Kg-dry	164273	5	07/27/2012 01:17	YH
Surr: 2,4,6-Tribromophenol	76.2	41.1-130		%REC	164273	5	07/27/2012 01:17	YH
Surr: 2-Fluorobiphenyl	82.6	45-120		%REC	164273	5	07/27/2012 01:17	YH
Surr: 2-Fluorophenol	66.2	35-120		%REC	164273	5	07/27/2012 01:17	YH
Surr: 4-Terphenyl-d14	94.5	50.1-123		%REC	164273	5	07/27/2012 01:17	YH
Surr: Nitrobenzene-d5	68.8	37.5-120		%REC	164273	5	07/27/2012 01:17	YH
Surr: Phenol-d5	67.2	39-120		%REC	164273	5	07/27/2012 01:17	YH
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,1,1-Trichloroethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,1,2,2-Tetrachloroethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,1,2-Trichloroethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,1-Dichloroethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,1-Dichloroethene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,2,4-Trichlorobenzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-1@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 9:35:00 AM
Lab ID:	1207H10-002	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,2-Dibromo-3-chloropropane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,2-Dibromoethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,2-Dichlorobenzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,2-Dichloroethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,2-Dichloropropane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,3-Dichlorobenzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
1,4-Dichlorobenzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
2-Butanone	BRL	58		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
2-Hexanone	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
4-Methyl-2-pentanone	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Acetone	BRL	120		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Benzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Bromodichloromethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Bromoform	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Bromomethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Carbon disulfide	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Carbon tetrachloride	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Chlorobenzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Chloroethane	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Chloroform	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Chloromethane	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
cis-1,2-Dichloroethene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
cis-1,3-Dichloropropene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Cyclohexane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Dibromochloromethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Dichlorodifluoromethane	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Ethylbenzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Freon-113	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Isopropylbenzene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
m,p-Xylene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Methyl acetate	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Methyl tert-butyl ether	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Methylcyclohexane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Methylene chloride	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
o-Xylene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Styrene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Tetrachloroethene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Toluene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
trans-1,2-Dichloroethene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
trans-1,3-Dichloropropene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Trichloroethene	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-1@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 9:35:00 AM
Lab ID:	1207H10-002	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
Trichlorofluoromethane	BRL	5.8		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Vinyl chloride	BRL	12		ug/Kg-dry	164405	1	07/26/2012 16:09	JE
Surr: 4-Bromofluorobenzene	83.5	56.5-134		%REC	164405	1	07/26/2012 16:09	JE
Surr: Dibromofluoromethane	107	71.8-135		%REC	164405	1	07/26/2012 16:09	JE
Surr: Toluene-d8	92.3	77.1-117		%REC	164405	1	07/26/2012 16:09	JE
METALS, TOTAL SW6010C				(SW3050B)				
Arsenic	15.9	15.1		mg/Kg-dry	164343	2	07/27/2012 15:53	TA
Barium	368	7.53		mg/Kg-dry	164343	1	07/27/2012 10:55	TA
Cadmium	BRL	3.77		mg/Kg-dry	164343	1	07/27/2012 10:55	TA
Chromium	30.6	3.77		mg/Kg-dry	164343	1	07/27/2012 10:55	TA
Lead	982	7.53		mg/Kg-dry	164343	1	07/27/2012 10:55	TA
Selenium	BRL	30.1		mg/Kg-dry	164343	4	07/27/2012 15:50	TA
Silver	BRL	3.77		mg/Kg-dry	164343	1	07/27/2012 10:55	TA
PERCENT MOISTURE D2216								
Percent Moisture	34.5	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

* Value exceeds maximum contaminant level	E Estimated (value above quantitation range)
BRL Below reporting limit	S Spike Recovery outside limits due to matrix
H Holding times for preparation or analysis exceeded	Narr See case narrative
N Analyte not NELAC certified	NC Not confirmed
B Analyte detected in the associated method blank	< Less than Result value
> Greater than Result value	J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-2@1
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 10:05:00 AM
Lab ID:	1207H10-003	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B				(SW7471B)				
Mercury	BRL	0.121		mg/Kg-dry	164332	1	07/26/2012 14:42	LD
METALS, TOTAL SW6010C				(SW3050B)				
Arsenic	BRL	5.63		mg/Kg-dry	164343	1	07/27/2012 10:58	TA
Barium	191	5.63		mg/Kg-dry	164343	1	07/27/2012 10:58	TA
Cadmium	BRL	2.82		mg/Kg-dry	164343	1	07/27/2012 10:58	TA
Chromium	16.8	2.82		mg/Kg-dry	164343	1	07/27/2012 10:58	TA
Lead	455	5.63		mg/Kg-dry	164343	1	07/27/2012 10:58	TA
Selenium	BRL	5.63		mg/Kg-dry	164343	1	07/27/2012 10:58	TA
Silver	BRL	2.82		mg/Kg-dry	164343	1	07/27/2012 10:58	TA
PERCENT MOISTURE D2216								
Percent Moisture	18.6	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-2@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 10:30:00 AM
Lab ID:	1207H10-004	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					(SW7471B)			
Mercury	0.184	0.138		mg/Kg-dry	164332	1	07/26/2012 14:45	LD
TCL-SEMIVOLATILE ORGANICS SW8270D					(SW3550C)			
1,1'-Biphenyl	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2,4,5-Trichlorophenol	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2,4,6-Trichlorophenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2,4-Dichlorophenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2,4-Dimethylphenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2,4-Dinitrophenol	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2,4-Dinitrotoluene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2,6-Dinitrotoluene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2-Chloronaphthalene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2-Chlorophenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2-Methylnaphthalene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2-Methylphenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2-Nitroaniline	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
2-Nitrophenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
3,3'-Dichlorobenzidine	BRL	4600		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
3-Nitroaniline	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4,6-Dinitro-2-methylphenol	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4-Bromophenyl phenyl ether	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4-Chloro-3-methylphenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4-Chloroaniline	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4-Chlorophenyl phenyl ether	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4-Methylphenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4-Nitroaniline	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
4-Nitrophenol	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Acenaphthene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Acenaphthylene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Acetophenone	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Anthracene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Atrazine	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Benz(a)anthracene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Benzaldehyde	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Benzo(a)pyrene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Benzo(b)fluoranthene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Benzo(g,h,i)perylene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Benzo(k)fluoranthene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Bis(2-chloroethoxy)methane	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Bis(2-chloroethyl)ether	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Bis(2-chloroisopropyl)ether	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-2@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 10:30:00 AM
Lab ID:	1207H10-004	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3550C)				
Bis(2-ethylhexyl)phthalate	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Butyl benzyl phthalate	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Caprolactam	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Carbazole	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Chrysene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Di-n-butyl phthalate	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Di-n-octyl phthalate	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Dibenz(a,h)anthracene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Dibenzofuran	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Diethyl phthalate	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Dimethyl phthalate	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Fluoranthene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Fluorene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Hexachlorobenzene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Hexachlorobutadiene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Hexachlorocyclopentadiene	BRL	4600		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Hexachloroethane	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Indeno(1,2,3-cd)pyrene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Isophorone	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
N-Nitrosodi-n-propylamine	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
N-Nitrosodiphenylamine	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Naphthalene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Nitrobenzene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Pentachlorophenol	BRL	12000		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Phenanthrene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Phenol	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Pyrene	BRL	2300		ug/Kg-dry	164273	5	07/27/2012 01:44	YH
Surr: 2,4,6-Tribromophenol	68.7	41.1-130		%REC	164273	5	07/27/2012 01:44	YH
Surr: 2-Fluorobiphenyl	74.8	45-120		%REC	164273	5	07/27/2012 01:44	YH
Surr: 2-Fluorophenol	61.7	35-120		%REC	164273	5	07/27/2012 01:44	YH
Surr: 4-Terphenyl-d14	85.6	50.1-123		%REC	164273	5	07/27/2012 01:44	YH
Surr: Nitrobenzene-d5	66.3	37.5-120		%REC	164273	5	07/27/2012 01:44	YH
Surr: Phenol-d5	59.7	39-120		%REC	164273	5	07/27/2012 01:44	YH
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,1,1-Trichloroethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,1,2,2-Tetrachloroethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,1,2-Trichloroethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,1-Dichloroethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,1-Dichloroethene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,2,4-Trichlorobenzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-2@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 10:30:00 AM
Lab ID:	1207H10-004	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,2-Dibromo-3-chloropropane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,2-Dibromoethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,2-Dichlorobenzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,2-Dichloroethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,2-Dichloropropane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,3-Dichlorobenzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
1,4-Dichlorobenzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
2-Butanone	BRL	55		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
2-Hexanone	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
4-Methyl-2-pentanone	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Acetone	BRL	110		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Benzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Bromodichloromethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Bromoform	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Bromomethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Carbon disulfide	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Carbon tetrachloride	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Chlorobenzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Chloroethane	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Chloroform	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Chloromethane	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
cis-1,2-Dichloroethene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
cis-1,3-Dichloropropene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Cyclohexane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Dibromochloromethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Dichlorodifluoromethane	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Ethylbenzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Freon-113	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Isopropylbenzene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
m,p-Xylene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Methyl acetate	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Methyl tert-butyl ether	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Methylcyclohexane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Methylene chloride	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
o-Xylene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Styrene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Tetrachloroethene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Toluene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
trans-1,2-Dichloroethene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
trans-1,3-Dichloropropene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Trichloroethene	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- :> Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- NAR See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-2@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 10:30:00 AM
Lab ID:	1207H10-004	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5035)**				
Trichlorofluoromethane	BRL	5.5		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Vinyl chloride	BRL	11		ug/Kg-dry	164405	1	07/26/2012 18:09	JE
Surr: 4-Bromofluorobenzene	93.4	56.5-134		%REC	164405	1	07/26/2012 18:09	JE
Surr: Dibromofluoromethane	99.1	71.8-135		%REC	164405	1	07/26/2012 18:09	JE
Surr: Toluene-d8	87.4	77.1-117		%REC	164405	1	07/26/2012 18:09	JE
METALS, TOTAL SW6010C				**(SW3050B)**				
Arsenic	BRL	6.32		mg/Kg-dry	164343	1	07/27/2012 11:01	TA
Barium	122	6.32		mg/Kg-dry	164343	1	07/27/2012 11:01	TA
Cadmium	BRL	3.16		mg/Kg-dry	164343	1	07/27/2012 11:01	TA
Chromium	15.5	3.16		mg/Kg-dry	164343	1	07/27/2012 11:01	TA
Lead	466	6.32		mg/Kg-dry	164343	1	07/27/2012 11:01	TA
Selenium	BRL	6.32		mg/Kg-dry	164343	1	07/27/2012 11:01	TA
Silver	BRL	3.16		mg/Kg-dry	164343	1	07/27/2012 11:01	TA
PERCENT MOISTURE D2216								
Percent Moisture	28.0	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:	* Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
	BRL Below reporting limit	S	Spike Recovery outside limits due to matrix
	H Holding times for preparation or analysis exceeded	Narr	See case narrative
	N Analyte not NELAC certified	NC	Not confirmed
	B Analyte detected in the associated method blank	<	Less than Result value
	> Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-3@1
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 10:55:00 AM
Lab ID:	1207H10-005	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B				**(SW7471B)**				
Mercury	BRL	0.113		mg/Kg-dry	164332	1	07/26/2012 14:51	LD
METALS, TOTAL SW6010C				**(SW3050B)**				
Arsenic	BRL	5.39		mg/Kg-dry	164343	1	07/27/2012 13:44	TA
Barium	105	5.39		mg/Kg-dry	164343	1	07/27/2012 11:13	TA
Cadmium	BRL	2.70		mg/Kg-dry	164343	1	07/27/2012 11:13	TA
Chromium	36.4	2.70		mg/Kg-dry	164343	1	07/27/2012 11:13	TA
Lead	BRL	5.39		mg/Kg-dry	164343	1	07/27/2012 11:13	TA
Selenium	BRL	5.39		mg/Kg-dry	164343	1	07/27/2012 11:13	TA
Silver	BRL	2.70		mg/Kg-dry	164343	1	07/27/2012 11:13	TA
PERCENT MOISTURE D2216								
Percent Moisture	13.2	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-3@3
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 11:10:00 AM
Lab ID:	1207H10-006	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					(SW7471B)			
Mercury	BRL	0.116		mg/Kg-dry	164332	1	07/26/2012 14:53	LD
TCL-SEMIVOLATILE ORGANICS SW8270D					(SW3550C)			
1,1'-Biphenyl	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2,4,5-Trichlorophenol	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2,4,6-Trichlorophenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2,4-Dichlorophenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2,4-Dimethylphenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2,4-Dinitrophenol	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2,4-Dinitrotoluene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2,6-Dinitrotoluene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2-Chloronaphthalene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2-Chlorophenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2-Methylnaphthalene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2-Methylphenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2-Nitroaniline	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
2-Nitrophenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
3,3'-Dichlorobenzidine	BRL	780		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
3-Nitroaniline	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4,6-Dinitro-2-methylphenol	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4-Bromophenyl phenyl ether	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4-Chloro-3-methylphenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4-Chloroaniline	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4-Chlorophenyl phenyl ether	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4-Methylphenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4-Nitroaniline	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
4-Nitrophenol	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Acenaphthene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Acenaphthylene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Acetophenone	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Anthracene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Atrazine	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Benz(a)anthracene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Benzaldehyde	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Benzo(a)pyrene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Benzo(b)fluoranthene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Benzo(g,h,i)perylene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Benzo(k)fluoranthene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Bis(2-chloroethoxy)methane	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Bis(2-chloroethyl)ether	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Bis(2-chloroisopropyl)ether	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-3@3
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 11:10:00 AM
Lab ID:	1207H10-006	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3550C)				
Bis(2-ethylhexyl)phthalate	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Butyl benzyl phthalate	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Caprolactam	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Carbazole	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Chrysene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Di-n-butyl phthalate	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Di-n-octyl phthalate	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Dibenz(a,h)anthracene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Dibenzofuran	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Diethyl phthalate	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Dimethyl phthalate	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Fluoranthene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Fluorene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Hexachlorobenzene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Hexachlorobutadiene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Hexachlorocyclopentadiene	BRL	770		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Hexachloroethane	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Indeno(1,2,3-cd)pyrene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Isophorone	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
N-Nitrosodi-n-propylamine	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
N-Nitrosodiphenylamine	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Naphthalene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Nitrobenzene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Pentachlorophenol	BRL	2000		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Phenanthrene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Phenol	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Pyrene	BRL	390		ug/Kg-dry	164273	1	07/26/2012 22:40	YH
Surr: 2,4,6-Tribromophenol	77.6	41.1-130		%REC	164273	1	07/26/2012 22:40	YH
Surr: 2-Fluorobiphenyl	73.9	45-120		%REC	164273	1	07/26/2012 22:40	YH
Surr: 2-Fluorophenol	60.4	35-120		%REC	164273	1	07/26/2012 22:40	YH
Surr: 4-Terphenyl-d14	93.9	50.1-123		%REC	164273	1	07/26/2012 22:40	YH
Surr: Nitrobenzene-d5	61.7	37.5-120		%REC	164273	1	07/26/2012 22:40	YH
Surr: Phenol-d5	61.3	39-120		%REC	164273	1	07/26/2012 22:40	YH
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,1,1-Trichloroethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,1,2,2-Tetrachloroethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,1,2-Trichloroethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,1-Dichloroethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,1-Dichloroethene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,2,4-Trichlorobenzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-3@3
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 11:10:00 AM
Lab ID:	1207H10-006	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,2-Dibromo-3-chloropropane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,2-Dibromoethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,2-Dichlorobenzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,2-Dichloroethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,2-Dichloropropane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,3-Dichlorobenzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
1,4-Dichlorobenzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
2-Butanone	BRL	43		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
2-Hexanone	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
4-Methyl-2-pentanone	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Acetone	BRL	87		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Benzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Bromodichloromethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Bromoform	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Bromomethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Carbon disulfide	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Carbon tetrachloride	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Chlorobenzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Chloroethane	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Chloroform	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Chloromethane	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
cis-1,2-Dichloroethene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
cis-1,3-Dichloropropene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Cyclohexane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Dibromochloromethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Dichlorodifluoromethane	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Ethylbenzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Freon-113	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Isopropylbenzene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
m,p-Xylene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Methyl acetate	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Methyl tert-butyl ether	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Methylcyclohexane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Methylene chloride	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
o-Xylene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Styrene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Tetrachloroethene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Toluene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
trans-1,2-Dichloroethene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
trans-1,3-Dichloropropene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Trichloroethene	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-3@3
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 11:10:00 AM
Lab ID:	1207H10-006	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5035)**				
Trichlorofluoromethane	BRL	4.3		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Vinyl chloride	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 19:25	JE
Surr: 4-Bromofluorobenzene	103	56.5-134		%REC	164405	1	07/26/2012 19:25	JE
Surr: Dibromofluoromethane	98.5	71.8-135		%REC	164405	1	07/26/2012 19:25	JE
Surr: Toluene-d8	95.9	77.1-117		%REC	164405	1	07/26/2012 19:25	JE
METALS, TOTAL SW6010C				**(SW3050B)**				
Arsenic	BRL	5.85		mg/Kg-dry	164343	1	07/27/2012 13:47	TA
Barium	93.1	5.85		mg/Kg-dry	164343	1	07/27/2012 11:16	TA
Cadmium	BRL	2.92		mg/Kg-dry	164343	1	07/27/2012 11:16	TA
Chromium	43.7	2.92		mg/Kg-dry	164343	1	07/27/2012 11:16	TA
Lead	BRL	5.85		mg/Kg-dry	164343	1	07/27/2012 11:16	TA
Selenium	BRL	5.85		mg/Kg-dry	164343	1	07/27/2012 11:16	TA
Silver	BRL	2.92		mg/Kg-dry	164343	1	07/27/2012 11:16	TA
PERCENT MOISTURE D2216								
Percent Moisture	14.6	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@1
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 12:05:00 PM
Lab ID:	1207H10-007	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B				(SW7471B)				
Mercury	BRL	0.116		mg/Kg-dry	164332	1	07/26/2012 14:56	LD
METALS, TOTAL SW6010C				(SW3050B)				
Arsenic	BRL	5.65		mg/Kg-dry	164343	1	07/27/2012 11:18	TA
Barium	138	5.65		mg/Kg-dry	164343	1	07/27/2012 11:18	TA
Cadmium	BRL	2.82		mg/Kg-dry	164343	1	07/27/2012 11:18	TA
Chromium	130	2.82		mg/Kg-dry	164343	1	07/27/2012 11:18	TA
Lead	101	5.65		mg/Kg-dry	164343	1	07/27/2012 11:18	TA
Selenium	BRL	5.65		mg/Kg-dry	164343	1	07/27/2012 11:18	TA
Silver	BRL	2.82		mg/Kg-dry	164343	1	07/27/2012 11:18	TA
PERCENT MOISTURE D2216								
Percent Moisture	15.6	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 12:30:00 PM
Lab ID:	1207H10-008	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					(SW7471B)			
Mercury	BRL	0.127		mg/Kg-dry	164332	1	07/26/2012 14:58	LD
TCL-SEMIVOLATILE ORGANICS SW8270D					(SW3550C)			
1,1'-Biphenyl	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2,4,5-Trichlorophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2,4,6-Trichlorophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2,4-Dichlorophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2,4-Dimethylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2,4-Dinitrophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2,4-Dinitrotoluene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2,6-Dinitrotoluene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2-Chloronaphthalene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2-Chlorophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2-Methylnaphthalene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2-Methylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2-Nitroaniline	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
2-Nitrophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
3,3'-Dichlorobenzidine	BRL	860		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
3-Nitroaniline	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4,6-Dinitro-2-methylphenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4-Bromophenyl phenyl ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4-Chloro-3-methylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4-Chloroaniline	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4-Chlorophenyl phenyl ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4-Methylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4-Nitroaniline	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
4-Nitrophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Acenaphthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Acenaphthylene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Acetophenone	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Anthracene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Atrazine	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Benz(a)anthracene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Benzaldehyde	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Benzo(a)pyrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Benzo(b)fluoranthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Benzo(g,h,i)perylene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Benzo(k)fluoranthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Bis(2-chloroethoxy)methane	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Bis(2-chloroethyl)ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Bis(2-chloroisopropyl)ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 12:30:00 PM
Lab ID:	1207H10-008	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3550C)				
Bis(2-ethylhexyl)phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Butyl benzyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Caprolactam	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Carbazole	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Chrysene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Di-n-butyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Di-n-octyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Dibenz(a,h)anthracene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Dibenzofuran	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Diethyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Dimethyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Fluoranthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Fluorene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Hexachlorobenzene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Hexachlorobutadiene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Hexachlorocyclopentadiene	BRL	850		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Hexachloroethane	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Indeno(1,2,3-cd)pyrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Isophorone	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
N-Nitrosodi-n-propylamine	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
N-Nitrosodiphenylamine	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Naphthalene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Nitrobenzene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Pentachlorophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Phenanthrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Phenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Pyrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:32	YH
Surr: 2,4,6-Tribromophenol	85	41.1-130		%REC	164273	1	07/26/2012 23:32	YH
Surr: 2-Fluorobiphenyl	78.3	45-120		%REC	164273	1	07/26/2012 23:32	YH
Surr: 2-Fluorophenol	65.9	35-120		%REC	164273	1	07/26/2012 23:32	YH
Surr: 4-Terphenyl-d14	98.1	50.1-123		%REC	164273	1	07/26/2012 23:32	YH
Surr: Nitrobenzene-d5	66.5	37.5-120		%REC	164273	1	07/26/2012 23:32	YH
Surr: Phenol-d5	66.8	39-120		%REC	164273	1	07/26/2012 23:32	YH
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,1,1-Trichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,1,2,2-Tetrachloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,1,2-Trichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,1-Dichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,1-Dichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,2,4-Trichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 12:30:00 PM
Lab ID:	1207H10-008	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,2-Dibromo-3-chloropropane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,2-Dibromoethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,2-Dichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,2-Dichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,2-Dichloropropane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,3-Dichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
1,4-Dichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
2-Butanone	BRL	44		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
2-Hexanone	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
4-Methyl-2-pentanone	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Acetone	BRL	88		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Benzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Bromodichloromethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Bromoform	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Bromomethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Carbon disulfide	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Carbon tetrachloride	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Chlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Chloroethane	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Chloroform	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Chloromethane	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
cis-1,2-Dichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
cis-1,3-Dichloropropene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Cyclohexane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Dibromochloromethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Dichlorodifluoromethane	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Ethylbenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Freon-113	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Isopropylbenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
m,p-Xylene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Methyl acetate	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Methyl tert-butyl ether	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Methylcyclohexane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Methylene chloride	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
o-Xylene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Styrene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Tetrachloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Toluene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
trans-1,2-Dichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
trans-1,3-Dichloropropene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Trichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- :> Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@6
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 12:30:00 PM
Lab ID:	1207H10-008	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
Trichlorofluoromethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Vinyl chloride	BRL	8.8		ug/Kg-dry	164405	1	07/26/2012 19:50	JE
Surr: 4-Bromofluorobenzene	99.2	56.5-134		%REC	164405	1	07/26/2012 19:50	JE
Surr: Dibromofluoromethane	100	71.8-135		%REC	164405	1	07/26/2012 19:50	JE
Surr: Toluene-d8	93.9	77.1-117		%REC	164405	1	07/26/2012 19:50	JE
METALS, TOTAL SW6010C				(SW3050B)				
Arsenic	BRL	6.11		mg/Kg-dry	164343	1	07/27/2012 11:21	TA
Barium	85.2	6.11		mg/Kg-dry	164343	1	07/27/2012 11:21	TA
Cadmium	BRL	3.05		mg/Kg-dry	164343	1	07/27/2012 11:21	TA
Chromium	43.1	3.05		mg/Kg-dry	164343	1	07/27/2012 11:21	TA
Lead	8.33	6.11		mg/Kg-dry	164343	1	07/27/2012 11:21	TA
Selenium	BRL	6.11		mg/Kg-dry	164343	1	07/27/2012 11:21	TA
Silver	BRL	3.05		mg/Kg-dry	164343	1	07/27/2012 11:21	TA
PERCENT MOISTURE D2216								
Percent Moisture	22.2	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 1:40:00 PM
Lab ID:	1207H10-009	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B				(SW7471B)				
Mercury	BRL	0.127		mg/Kg-dry	164332	1	07/26/2012 15:00	LD
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3550C)				
1,1'-Biphenyl	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2,4,5-Trichlorophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2,4,6-Trichlorophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2,4-Dichlorophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2,4-Dimethylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2,4-Dinitrophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2,4-Dinitrotoluene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2,6-Dinitrotoluene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2-Chloronaphthalene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2-Chlorophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2-Methylnaphthalene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2-Methylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2-Nitroaniline	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
2-Nitrophenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
3,3'-Dichlorobenzidine	BRL	860		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
3-Nitroaniline	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4,6-Dinitro-2-methylphenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4-Bromophenyl phenyl ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4-Chloro-3-methylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4-Chloroaniline	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4-Chlorophenyl phenyl ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4-Methylphenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4-Nitroaniline	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
4-Nitrophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Acenaphthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Acenaphthylene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Acetophenone	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Anthracene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Atrazine	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Benz(a)anthracene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Benzaldehyde	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Benzo(a)pyrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Benzo(b)fluoranthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Benzo(g,h,i)perylene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Benzo(k)fluoranthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Bis(2-chloroethoxy)methane	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Bis(2-chloroethyl)ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Bis(2-chloroisopropyl)ether	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 1:40:00 PM
Lab ID:	1207H10-009	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D				(SW3550C)				
Bis(2-ethylhexyl)phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Butyl benzyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Caprolactam	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Carbazole	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Chrysene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Di-n-butyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Di-n-octyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Dibenz(a,h)anthracene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Dibenzofuran	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Diethyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Dimethyl phthalate	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Fluoranthene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Fluorene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Hexachlorobenzene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Hexachlorobutadiene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Hexachlorocyclopentadiene	BRL	850		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Hexachloroethane	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Indeno(1,2,3-cd)pyrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Isophorone	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
N-Nitrosodi-n-propylamine	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
N-Nitrosodiphenylamine	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Naphthalene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Nitrobenzene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Pentachlorophenol	BRL	2200		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Phenanthrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Phenol	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Pyrene	BRL	420		ug/Kg-dry	164273	1	07/26/2012 23:05	YH
Surr: 2,4,6-Tribromophenol	71	41.1-130		%REC	164273	1	07/26/2012 23:05	YH
Surr: 2-Fluorobiphenyl	72.6	45-120		%REC	164273	1	07/26/2012 23:05	YH
Surr: 2-Fluorophenol	61.8	35-120		%REC	164273	1	07/26/2012 23:05	YH
Surr: 4-Terphenyl-d14	90.5	50.1-123		%REC	164273	1	07/26/2012 23:05	YH
Surr: Nitrobenzene-d5	61.1	37.5-120		%REC	164273	1	07/26/2012 23:05	YH
Surr: Phenol-d5	62.3	39-120		%REC	164273	1	07/26/2012 23:05	YH
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,1,1-Trichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,1,2,2-Tetrachloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,1,2-Trichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,1-Dichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,1-Dichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,2,4-Trichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE

Qualifiers:

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- BRL Below reporting limit
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- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 1:40:00 PM
Lab ID:	1207H10-009	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5035)				
1,2-Dibromo-3-chloropropane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,2-Dibromoethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,2-Dichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,2-Dichloroethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,2-Dichloropropane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,3-Dichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
1,4-Dichlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
2-Butanone	BRL	44		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
2-Hexanone	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
4-Methyl-2-pentanone	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Acetone	BRL	87		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Benzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Bromodichloromethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Bromoform	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Bromomethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Carbon disulfide	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Carbon tetrachloride	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Chlorobenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Chloroethane	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Chloroform	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Chloromethane	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
cis-1,2-Dichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
cis-1,3-Dichloropropene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Cyclohexane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Dibromochloromethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Dichlorodifluoromethane	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Ethylbenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Freon-113	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Isopropylbenzene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
m,p-Xylene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Methyl acetate	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Methyl tert-butyl ether	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Methylcyclohexane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Methylene chloride	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
o-Xylene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Styrene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Tetrachloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Toluene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
trans-1,2-Dichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
trans-1,3-Dichloropropene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Trichloroethene	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@2.5
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 1:40:00 PM
Lab ID:	1207H10-009	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5035)**				
Trichlorofluoromethane	BRL	4.4		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Vinyl chloride	BRL	8.7		ug/Kg-dry	164405	1	07/26/2012 20:16	JE
Surr: 4-Bromofluorobenzene	102	56.5-134		%REC	164405	1	07/26/2012 20:16	JE
Surr: Dibromofluoromethane	101	71.8-135		%REC	164405	1	07/26/2012 20:16	JE
Surr: Toluene-d8	95	77.1-117		%REC	164405	1	07/26/2012 20:16	JE
METALS, TOTAL SW6010C				**(SW3050B)**				
Arsenic	BRL	6.09		mg/Kg-dry	164343	1	07/27/2012 11:24	TA
Barium	80.9	6.09		mg/Kg-dry	164343	1	07/27/2012 11:24	TA
Cadmium	BRL	3.04		mg/Kg-dry	164343	1	07/27/2012 11:24	TA
Chromium	40.2	3.04		mg/Kg-dry	164343	1	07/27/2012 11:24	TA
Lead	8.94	6.09		mg/Kg-dry	164343	1	07/27/2012 11:24	TA
Selenium	BRL	6.09		mg/Kg-dry	164343	1	07/27/2012 11:24	TA
Silver	BRL	3.04		mg/Kg-dry	164343	1	07/27/2012 11:24	TA
PERCENT MOISTURE D2216								
Percent Moisture	22.0	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	DUPLICATE
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 1:40:00 PM
Lab ID:	1207H10-010	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TOTAL MERCURY SW7471B					(SW7471B)			
Mercury	BRL	0.124		mg/Kg-dry	164332	1	07/26/2012 15:02	LD
METALS, TOTAL SW6010C					(SW3050B)			
Arsenic	BRL	6.01		mg/Kg-dry	164343	1	07/27/2012 13:49	TA
Barium	79.0	6.01		mg/Kg-dry	164343	1	07/27/2012 11:27	TA
Cadmium	BRL	3.00		mg/Kg-dry	164343	1	07/27/2012 11:27	TA
Chromium	47.7	3.00		mg/Kg-dry	164343	1	07/27/2012 11:27	TA
Lead	7.47	6.01		mg/Kg-dry	164343	1	07/27/2012 11:27	TA
Selenium	BRL	6.01		mg/Kg-dry	164343	1	07/27/2012 11:27	TA
Silver	BRL	3.00		mg/Kg-dry	164343	1	07/27/2012 11:27	TA
PERCENT MOISTURE D2216								
Percent Moisture	20.9	0		wt%	R225921	1	07/27/2012 12:00	AS

Qualifiers:

* Value exceeds maximum contaminant level	E Estimated (value above quantitation range)
BRL Below reporting limit	S Spike Recovery outside limits due to matrix
H Holding times for preparation or analysis exceeded	Narr See case narrative
N Analyte not NELAC certified	NC Not confirmed
B Analyte detected in the associated method blank	< Less than Result value
> Greater than Result value	J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-1TO 4
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 12:40:00 PM
Lab ID:	1207H10-011	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
MERCURY, TCLP SW1311/7470A					(SW7470A)			
Mercury	BRL	0.00400		mg/L	164362	1	07/27/2012 14:00	MW
ICP METALS, TCLP SW1311/6010C					(SW3010A)			
Arsenic	BRL	0.250		mg/L	164346	1	07/27/2012 12:01	MR
Barium	0.941	0.500		mg/L	164346	1	07/27/2012 12:01	MR
Cadmium	BRL	0.0250		mg/L	164346	1	07/27/2012 12:01	MR
Chromium	BRL	0.0500		mg/L	164346	1	07/27/2012 12:01	MR
Lead	BRL	0.0500		mg/L	164346	1	07/27/2012 12:01	MR
Selenium	BRL	0.100		mg/L	164346	1	07/27/2012 12:01	MR
Silver	BRL	0.0250		mg/L	164346	1	07/27/2012 12:01	MR

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TP-4@2
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 11:40:00 AM
Lab ID:	1207H10-012	**Matrix:**	Soil

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
VOLATILES, TCLP SW1311/8260B				(SW1311)				
1,1-Dichloroethene	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
1,2-Dichloroethane	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
2-Butanone	BRL	0.20		mg/L	164411	20	07/27/2012 12:50	DB
Benzene	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
Carbon tetrachloride	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
Chlorobenzene	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
Chloroform	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
Tetrachloroethene	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
Trichloroethene	BRL	0.10		mg/L	164411	20	07/27/2012 12:50	DB
Vinyl chloride	BRL	0.040		mg/L	164411	20	07/27/2012 12:50	DB
Surr: 4-Bromofluorobenzene	95.5	64.6-131		%REC	164411	20	07/27/2012 12:50	DB
Surr: Dibromofluoromethane	98.6	70.6-128		%REC	164411	20	07/27/2012 12:50	DB
Surr: Toluene-d8	99	70.5-116		%REC	164411	20	07/27/2012 12:50	DB
SEMIVOLATILES ORGANICS, TCLP SW1311/8270D				(SW3510C)				
1,4-Dichlorobenzene	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
2,4,5-Trichlorophenol	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
2,4,6-Trichlorophenol	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
2,4-Dinitrotoluene	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
Hexachlorobenzene	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
Hexachlorobutadiene	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
Hexachloroethane	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
m,p-Cresol	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
Nitrobenzene	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
o-Cresol	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
Pentachlorophenol	BRL	0.50		mg/L	164271	1	07/27/2012 12:29	YH
Pyridine	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
Cresols, Total	BRL	0.10		mg/L	164271	1	07/27/2012 12:29	YH
Surr: 2,4,6-Tribromophenol	82	48.3-142		%REC	164271	1	07/27/2012 12:29	YH
Surr: 2-Fluorobiphenyl	83.9	52.2-126		%REC	164271	1	07/27/2012 12:29	YH
Surr: 2-Fluorophenol	75.1	42.4-125		%REC	164271	1	07/27/2012 12:29	YH
Surr: 4-Terphenyl-d14	98.7	47-140		%REC	164271	1	07/27/2012 12:29	YH
Surr: Nitrobenzene-d5	76.9	47.3-129		%REC	164271	1	07/27/2012 12:29	YH
Surr: Phenol-d5	70.1	40.3-124		%REC	164271	1	07/27/2012 12:29	YH

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TRIP BLANK
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012
Lab ID:	1207H10-013	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				(SW5030B)				
1,1,1-Trichloroethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,1,2,2-Tetrachloroethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,1,2-Trichloroethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,1-Dichloroethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,1-Dichloroethene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,2,4-Trichlorobenzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,2-Dibromo-3-chloropropane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,2-Dibromoethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,2-Dichlorobenzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,2-Dichloroethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,2-Dichloropropane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,3-Dichlorobenzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
1,4-Dichlorobenzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
2-Butanone	BRL	50		ug/L	164385	1	07/26/2012 22:00	AR
2-Hexanone	BRL	10		ug/L	164385	1	07/26/2012 22:00	AR
4-Methyl-2-pentanone	BRL	10		ug/L	164385	1	07/26/2012 22:00	AR
Acetone	BRL	50		ug/L	164385	1	07/26/2012 22:00	AR
Benzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Bromodichloromethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Bromoform	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Bromomethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Carbon disulfide	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Carbon tetrachloride	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Chlorobenzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Chloroethane	BRL	10		ug/L	164385	1	07/26/2012 22:00	AR
Chloroform	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Chloromethane	BRL	10		ug/L	164385	1	07/26/2012 22:00	AR
cis-1,2-Dichloroethene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
cis-1,3-Dichloropropene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Cyclohexane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Dibromochloromethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Dichlorodifluoromethane	BRL	10		ug/L	164385	1	07/26/2012 22:00	AR
Ethylbenzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Freon-113	BRL	10		ug/L	164385	1	07/26/2012 22:00	AR
Isopropylbenzene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
m,p-Xylene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Methyl acetate	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Methyl tert-butyl ether	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Methylcyclohexane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Methylene chloride	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
o-Xylene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR

Qualifiers:

- * Value exceeds maximum contaminant level
- BRL Below reporting limit
- H Holding times for preparation or analysis exceeded
- N Analyte not NELAC certified
- B Analyte detected in the associated method blank
- > Greater than Result value
- E Estimated (value above quantitation range)
- S Spike Recovery outside limits due to matrix
- Narr See case narrative
- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	TRIP BLANK
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012
Lab ID:	1207H10-013	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL VOLATILE ORGANICS SW8260B				**(SW5030B)**				
Styrene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Tetrachloroethene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Toluene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
trans-1,2-Dichloroethene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
trans-1,3-Dichloropropene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Trichloroethene	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Trichlorofluoromethane	BRL	5.0		ug/L	164385	1	07/26/2012 22:00	AR
Vinyl chloride	BRL	2.0		ug/L	164385	1	07/26/2012 22:00	AR
Surr: 4-Bromofluorobenzene	99	67.4-123		%REC	164385	1	07/26/2012 22:00	AR
Surr: Dibromofluoromethane	103	75.5-128		%REC	164385	1	07/26/2012 22:00	AR
Surr: Toluene-d8	94.2	70-120		%REC	164385	1	07/26/2012 22:00	AR

Qualifiers:

*	Value exceeds maximum contaminant level	E	Estimated (value above quantitation range)
BRL	Below reporting limit	S	Spike Recovery outside limits due to matrix
H	Holding times for preparation or analysis exceeded	Narr	See case narrative
N	Analyte not NELAC certified	NC	Not confirmed
B	Analyte detected in the associated method blank	<	Less than Result value
>	Greater than Result value	J	Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	FIELD BLANK
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 4:00:00 PM
Lab ID:	1207H10-014	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D					(SW3510C)			
1,1'-Biphenyl	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2,4,5-Trichlorophenol	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
2,4,6-Trichlorophenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2,4-Dichlorophenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2,4-Dimethylphenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2,4-Dinitrophenol	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
2,4-Dinitrotoluene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2,6-Dinitrotoluene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2-Chloronaphthalene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2-Chlorophenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2-Methylnaphthalene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2-Methylphenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
2-Nitroaniline	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
2-Nitrophenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
3,3'-Dichlorobenzidine	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
3-Nitroaniline	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
4,6-Dinitro-2-methylphenol	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
4-Bromophenyl phenyl ether	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
4-Chloro-3-methylphenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
4-Chloroaniline	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
4-Chlorophenyl phenyl ether	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
4-Methylphenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
4-Nitroaniline	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
4-Nitrophenol	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
Acenaphthene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Acenaphthylene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Acetophenone	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Anthracene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Atrazine	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Benz(a)anthracene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Benzaldehyde	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Benzo(a)pyrene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Benzo(b)fluoranthene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Benzo(g,h,i)perylene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Benzo(k)fluoranthene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Bis(2-chloroethoxy)methane	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Bis(2-chloroethyl)ether	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Bis(2-chloroisopropyl)ether	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Bis(2-ethylhexyl)phthalate	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Butyl benzyl phthalate	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Caprolactam	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH

Qualifiers:

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Analytical Environmental Services, Inc **Date:** 28-Jul-12

Client:	United Consulting Group Inc.	**Client Sample ID:**	FIELD BLANK
Project Name:	Liddell Drive Equalization Project	**Collection Date:**	7/25/2012 4:00:00 PM
Lab ID:	1207H10-014	**Matrix:**	Aqueous

Analyses	Result	Reporting Limit	Qual	Units	BatchID	Dilution Factor	Date Analyzed	Analyst
TCL-SEMIVOLATILE ORGANICS SW8270D					(SW3510C)			
Carbazole	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Chrysene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Di-n-butyl phthalate	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Di-n-octyl phthalate	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Dibenz(a,h)anthracene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Dibenzofuran	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Diethyl phthalate	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Dimethyl phthalate	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Fluoranthene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Fluorene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Hexachlorobenzene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Hexachlorobutadiene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Hexachlorocyclopentadiene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Hexachloroethane	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Indeno(1,2,3-cd)pyrene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Isophorone	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
N-Nitrosodi-n-propylamine	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
N-Nitrosodiphenylamine	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Naphthalene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Nitrobenzene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Pentachlorophenol	BRL	25		ug/L	164270	1	07/27/2012 12:03	YH
Phenanthrene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Phenol	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Pyrene	BRL	10		ug/L	164270	1	07/27/2012 12:03	YH
Surr: 2,4,6-Tribromophenol	66.1	47.4-146		%REC	164270	1	07/27/2012 12:03	YH
Surr: 2-Fluorobiphenyl	81.1	51.5-122		%REC	164270	1	07/27/2012 12:03	YH
Surr: 2-Fluorophenol	65.5	28.5-120		%REC	164270	1	07/27/2012 12:03	YH
Surr: 4-Terphenyl-d14	98.9	47.7-133		%REC	164270	1	07/27/2012 12:03	YH
Surr: Nitrobenzene-d5	72.8	45.7-120		%REC	164270	1	07/27/2012 12:03	YH
Surr: Phenol-d5	52.8	10.9-120		%REC	164270	1	07/27/2012 12:03	YH

Qualifiers:

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- NC Not confirmed
- < Less than Result value
- J Estimated value detected below Reporting Limit

Analytical Environmental Services, Inc.

Sample/Cooler Receipt Checklist

Client United Consulting Work Order Number 1207H60

Checklist completed by [signature] 07/25/2012
Signature Date

Carrier name: FedEx __ UPS __ Courier __ Client ✓ US Mail __ Other _____

Shipping container/cooler in good condition?	Yes ✓	No __	Not Present __
Custody seals intact on shipping container/cooler?	Yes __	No __	Not Present ✓
Custody seals intact on sample bottles?	Yes __	No __	Not Present ✓
Container/Temp Blank temperature in compliance? (4°C±2)*	Yes ✓	No __	

Cooler #1 3.7 Cooler #2 _____ Cooler #3 _____ Cooler #4 _____ Cooler#5 _____ Cooler #6 _____

Chain of custody present?	Yes ✓	No __
Chain of custody signed when relinquished and received?	Yes ✓	No __
Chain of custody agrees with sample labels?	Yes ✓	No __
Samples in proper container/bottle?	Yes ✓	No __
Sample containers intact?	Yes ✓	No __
Sufficient sample volume for indicated test?	Yes ✓	No __
All samples received within holding time?	Yes ✓	No __
Was TAT marked on the COC?	Yes ✓	No __
Proceed with Standard TAT as per project history?	Yes __	No __ Not Applicable ✓
Water - VOA vials have zero headspace?	No VOA vials submitted ✓	Yes __ No __
Water - pH acceptable upon receipt?	Yes ✓	No __ Not Applicable __

Adjusted? _____ Checked by JM

Sample Condition: Good ✓ Other(Explain) _____

(For diffusive samples or AIHA lead) Is a known blank included? Yes __ No ✓

See Case Narrative for resolution of the Non-Conformance.

* Samples do not have to comply with the given range for certain parameters.

\L\Quality Assurance\Checklists Procedures Sign-Off Templates\Checklists\Sample Receipt Checklists\Sample_Cooler_Receipt_Checklist

Client: United Consulting Group Inc.
Project: Liddell Drive Equalization Project
Lab Order: 1207H10

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
1207H10-001A	TP-1@1	7/25/2012 8:50:00AM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-001A	TP-1@1	7/25/2012 8:50:00AM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-001A	TP-1@1	7/25/2012 8:50:00AM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-002A	TP-1@2.5	7/25/2012 9:35:00AM	Soil	TCL VOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-002B	TP-1@2.5	7/25/2012 9:35:00AM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-002C	TP-1@2.5	7/25/2012 9:35:00AM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-002C	TP-1@2.5	7/25/2012 9:35:00AM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-002C	TP-1@2.5	7/25/2012 9:35:00AM	Soil	TCL-SEMIVOLATILE ORGANICS		07/26/2012	07/27/2012
1207H10-003A	TP-2@1	7/25/2012 10:05:00AM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-003A	TP-2@1	7/25/2012 10:05:00AM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-003A	TP-2@1	7/25/2012 10:05:00AM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-004A	TP-2@6	7/25/2012 10:30:00AM	Soil	TCL VOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-004B	TP-2@6	7/25/2012 10:30:00AM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-004C	TP-2@6	7/25/2012 10:30:00AM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-004C	TP-2@6	7/25/2012 10:30:00AM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-004C	TP-2@6	7/25/2012 10:30:00AM	Soil	TCL-SEMIVOLATILE ORGANICS		07/26/2012	07/27/2012
1207H10-005A	TP-3@1	7/25/2012 10:55:00AM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-005A	TP-3@1	7/25/2012 10:55:00AM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-005A	TP-3@1	7/25/2012 10:55:00AM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-006A	TP-3@3	7/25/2012 11:10:00AM	Soil	TCL VOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-006B	TP-3@3	7/25/2012 11:10:00AM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-006C	TP-3@3	7/25/2012 11:10:00AM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-006C	TP-3@3	7/25/2012 11:10:00AM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-006C	TP-3@3	7/25/2012 11:10:00AM	Soil	TCL-SEMIVOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-006C	TP-3@3	7/25/2012 11:10:00AM	Soil	Semivolatile Org. Comp. by GC/MS		07/26/2012	07/26/2012
1207H10-007A	TP-4@1	7/25/2012 12:05:00PM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-007A	TP-4@1	7/25/2012 12:05:00PM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-007A	TP-4@1	7/25/2012 12:05:00PM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-008A	TP-4@6	7/25/2012 12:30:00PM	Soil	TCL VOLATILE ORGANICS		07/26/2012	07/26/2012

Client: United Consulting Group Inc.
Project: Liddell Drive Equalization Project
Lab Order: 1207H10

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
1207H10-008B	TP-4@6	7/25/2012 12:30:00PM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-008C	TP-4@6	7/25/2012 12:30:00PM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-008C	TP-4@6	7/25/2012 12:30:00PM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-008C	TP-4@6	7/25/2012 12:30:00PM	Soil	PRIORITY POLLUTANT SEMIVOLATILE ORGAI		07/26/2012	07/26/2012
1207H10-008C	TP-4@6	7/25/2012 12:30:00PM	Soil	TCL-SEMIVOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-008C	TP-4@6	7/25/2012 12:30:00PM	Soil	Semivolatile Org. Comp. by GC/MS		07/26/2012	07/26/2012
1207H10-009A	TP-4@2.5	7/25/2012 1:40:00PM	Soil	TCL VOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-009B	TP-4@2.5	7/25/2012 1:40:00PM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-009C	TP-4@2.5	7/25/2012 1:40:00PM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-009C	TP-4@2.5	7/25/2012 1:40:00PM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-009C	TP-4@2.5	7/25/2012 1:40:00PM	Soil	TCL-SEMIVOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-009C	TP-4@2.5	7/25/2012 1:40:00PM	Soil	Semivolatile Org. Comp. by GC/MS		07/26/2012	07/26/2012
1207H10-010B	DUPLICATE	7/25/2012 1:40:00PM	Soil	PERCENT MOISTURE			07/27/2012
1207H10-010C	DUPLICATE	7/25/2012 1:40:00PM	Soil	TOTAL METALS BY ICP		07/26/2012	07/27/2012
1207H10-010C	DUPLICATE	7/25/2012 1:40:00PM	Soil	MERCURY		07/26/2012	07/26/2012
1207H10-011A	TP-1TO 4	7/25/2012 12:40:00PM	Soil	MERCURY, TCLP Leached	07/26/2012	07/27/2012	07/27/2012
1207H10-011A	TP-1TO 4	7/25/2012 12:40:00PM	Soil	ICP METALS, TCLP Leached	07/26/2012	07/27/2012	07/27/2012
1207H10-012A	TP-4@2	7/25/2012 11:40:00AM	Soil	VOLATILES, TCLP Leached	07/24/2012	07/27/2012	07/27/2012
1207H10-012B	TP-4@2	7/25/2012 11:40:00AM	Soil	TCLP SEMIVOLATILES ORGANICS	07/26/2012	07/27/2012	07/27/2012
1207H10-013A	TRIP BLANK	7/25/2012 12:00:00AM	Aqueous	TCL VOLATILE ORGANICS		07/26/2012	07/26/2012
1207H10-014A	FIELD BLANK	7/25/2012 4:00:00PM	Aqueous	TCL-SEMIVOLATILE ORGANICS		07/26/2012	07/27/2012

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: MB-164270 Client ID: Units: ug/L Prep Date: 07/25/2012 Run No: 225734
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D BatchID: 164270 Analysis Date: 07/25/2012 Seq No: 4725015

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1'-Biphenyl	BRL	10	0	0	0	0	0	0	0	0	
2,4,5-Trichlorophenol	BRL	25	0	0	0	0	0	0	0	0	
2,4,6-Trichlorophenol	BRL	10	0	0	0	0	0	0	0	0	
2,4-Dichlorophenol	BRL	10	0	0	0	0	0	0	0	0	
2,4-Dimethylphenol	BRL	10	0	0	0	0	0	0	0	0	
2,4-Dinitrophenol	BRL	25	0	0	0	0	0	0	0	0	
2,4-Dinitrotoluene	BRL	10	0	0	0	0	0	0	0	0	
2,6-Dinitrotoluene	BRL	10	0	0	0	0	0	0	0	0	
2-Chloronaphthalene	BRL	10	0	0	0	0	0	0	0	0	
2-Chlorophenol	BRL	10	0	0	0	0	0	0	0	0	
2-Methylnaphthalene	BRL	10	0	0	0	0	0	0	0	0	
2-Methylphenol	BRL	10	0	0	0	0	0	0	0	0	
2-Nitroaniline	BRL	25	0	0	0	0	0	0	0	0	
2-Nitrophenol	BRL	10	0	0	0	0	0	0	0	0	
3,3'-Dichlorobenzidine	BRL	10	0	0	0	0	0	0	0	0	
3-Nitroaniline	BRL	25	0	0	0	0	0	0	0	0	
4,6-Dinitro-2-methylphenol	BRL	25	0	0	0	0	0	0	0	0	
4-Bromophenyl phenyl ether	BRL	10	0	0	0	0	0	0	0	0	
4-Chloro-3-methylphenol	BRL	10	0	0	0	0	0	0	0	0	
4-Chloroaniline	BRL	10	0	0	0	0	0	0	0	0	
4-Chlorophenyl phenyl ether	BRL	10	0	0	0	0	0	0	0	0	
4-Methylphenol	BRL	10	0	0	0	0	0	0	0	0	
4-Nitroaniline	BRL	25	0	0	0	0	0	0	0	0	
4-Nitrophenol	BRL	25	0	0	0	0	0	0	0	0	
Acenaphthene	BRL	10	0	0	0	0	0	0	0	0	
Acenaphthylene	BRL	10	0	0	0	0	0	0	0	0	
Acetophenone	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Analytical Environmental Services, Inc

Date: 30-Jul-12

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: MB-164270 Client ID:
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/L Prep Date: 07/25/2012 Run No: 225734
BatchID: 164270 Analysis Date: 07/25/2012 Seq No: 4725015

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Anthracene	BRL	10	0	0	0	0	0	0	0	0	
Atrazine	BRL	10	0	0	0	0	0	0	0	0	
Benz(a)anthracene	BRL	10	0	0	0	0	0	0	0	0	
Benzaldehyde	BRL	10	0	0	0	0	0	0	0	0	
Benzo(a)pyrene	BRL	10	0	0	0	0	0	0	0	0	
Benzo(b)fluoranthene	BRL	10	0	0	0	0	0	0	0	0	
Benzo(g,h,i)perylene	BRL	10	0	0	0	0	0	0	0	0	
Benzo(k)fluoranthene	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-chloroethoxy)methane	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-chloroethyl)ether	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-chloroisopropyl)ether	BRL	10	0	0	0	0	0	0	0	0	
Bis(2-ethylhexyl)phthalate	BRL	10	0	0	0	0	0	0	0	0	
Butyl benzyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Caprolactam	BRL	10	0	0	0	0	0	0	0	0	
Carbazole	BRL	10	0	0	0	0	0	0	0	0	
Chrysene	BRL	10	0	0	0	0	0	0	0	0	
Di-n-butyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Di-n-octyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Dibenz(a,h)anthracene	BRL	10	0	0	0	0	0	0	0	0	
Dibenzofuran	BRL	10	0	0	0	0	0	0	0	0	
Diethyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Dimethyl phthalate	BRL	10	0	0	0	0	0	0	0	0	
Fluoranthene	BRL	10	0	0	0	0	0	0	0	0	
Fluorene	BRL	10	0	0	0	0	0	0	0	0	
Hexachlorobenzene	BRL	10	0	0	0	0	0	0	0	0	
Hexachlorobutadiene	BRL	10	0	0	0	0	0	0	0	0	
Hexachlorocyclopentadiene	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: MB-164270 Client ID:
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/L Prep Date: 07/25/2012 Run No: 225734
BatchID: 164270 Analysis Date: 07/25/2012 Seq No: 4725015

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Hexachloroethane	BRL	10	0	0	0	0	0	0	0	0	
Indeno(1,2,3-cd)pyrene	BRL	10	0	0	0	0	0	0	0	0	
Isophorone	BRL	10	0	0	0	0	0	0	0	0	
N-Nitrosodi-n-propylamine	BRL	10	0	0	0	0	0	0	0	0	
N-Nitrosodiphenylamine	BRL	10	0	0	0	0	0	0	0	0	
Naphthalene	BRL	10	0	0	0	0	0	0	0	0	
Nitrobenzene	BRL	10	0	0	0	0	0	0	0	0	
Pentachlorophenol	BRL	25	0	0	0	0	0	0	0	0	
Phenanthrene	BRL	10	0	0	0	0	0	0	0	0	
Phenol	BRL	10	0	0	0	0	0	0	0	0	
Pyrene	BRL	10	0	0	0	0	0	0	0	0	
Surr: 2,4,6-Tribromophenol	96.77	0	100	0	96.8	47.4	146	0	0	0	
Surr: 2-Fluorobiphenyl	46.80	0	50	0	93.6	51.5	122	0	0	0	
Surr: 2-Fluorophenol	67.57	0	100	0	67.6	28.5	120	0	0	0	
Surr: 4-Terphenyl-d14	58.46	0	50	0	117	47.7	133	0	0	0	
Surr: Nitrobenzene-d5	39.99	0	50	0	80	45.7	120	0	0	0	
Surr: Phenol-d5	46.57	0	100	0	46.6	10.9	120	0	0	0	

Sample ID: LCS-164270 Client ID:
SampleType: LCS TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/L Prep Date: 07/25/2012 Run No: 225809
BatchID: 164270 Analysis Date: 07/26/2012 Seq No: 4726740

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	76.69	10	100	0	76.7	68.2	118	0	0	0	
2-Chlorophenol	68.43	10	100	0	68.4	67.9	120	0	0	0	
4-Chloro-3-methylphenol	76.44	10	100	0	76.4	63.1	120	0	0	0	
4-Nitrophenol	31.71	25	100	0	31.7	21	120	0	0	0	
Acenaphthene	72.30	10	100	0	72.3	68.6	120	0	0	0	
N-Nitrosodi-n-propylamine	74.17	10	100	0	74.2	73.6	127	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: **LCS-164270** Client ID:
SampleType: **LCS** TestCode: **TCL-SEMIVOLATILE ORGANICS SW8270D**
Units: **ug/L** Prep Date: **07/25/2012** Run No: **225809**
BatchID: **164270** Analysis Date: **07/26/2012** Seq No: **4726740**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Pentachlorophenol	75.30	25	100	0	75.3	55.2	118	0	0	0	
Phenol	37.73	10	100	0	37.7	26.6	120	0	0	0	
Pyrene	82.48	10	100	0	82.5	66.3	131	0	0	0	
Surr: 2,4,6-Tribromophenol	87.90	0	100	0	87.9	47.4	146	0	0	0	
Surr: 2-Fluorobiphenyl	39.36	0	50	0	78.7	51.5	122	0	0	0	
Surr: 2-Fluorophenol	52.53	0	100	0	52.5	28.5	120	0	0	0	
Surr: 4-Terphenyl-d14	50.49	0	50	0	101	47.7	133	0	0	0	
Surr: Nitrobenzene-d5	35.05	0	50	0	70.1	45.7	120	0	0	0	
Surr: Phenol-d5	35.61	0	100	0	35.6	10.9	120	0	0	0	

Sample ID: **1207D55-016CMS** Client ID:
SampleType: **MS** TestCode: **TCL-SEMIVOLATILE ORGANICS SW8270D**
Units: **ug/L** Prep Date: **07/25/2012** Run No: **225809**
BatchID: **164270** Analysis Date: **07/26/2012** Seq No: **4728335**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	68.85	50	100	0	68.8	54.4	120	0	0	0	
2-Chlorophenol	74.65	50	100	0	74.6	56.6	120	0	0	0	
4-Chloro-3-methylphenol	BRL	50	100	0	0	49.8	120	0	0	0	S
4-Nitrophenol	BRL	130	100	0	85.8	22	120	0	0	0	
Acenaphthene	401.4	50	100	491.6	-90.1	57.8	120	0	0	0	S
N-Nitrosodi-n-propylamine	BRL	50	100	0	0	60.7	124	0	0	0	S
Pentachlorophenol	160.4	130	100	113.8	46.6	37.6	130	0	0	0	
Phenol	2283	50	100	2390	-107	27.9	120	0	0	0	SE
Pyrene	130.3	50	100	86.05	44.2	57.9	118	0	0	0	S
Surr: 2,4,6-Tribromophenol	80.95	0	100	0	81	47.4	146	0	0	0	
Surr: 2-Fluorobiphenyl	35.10	0	50	0	70.2	51.5	122	0	0	0	
Surr: 2-Fluorophenol	55.60	0	100	0	55.6	28.5	120	0	0	0	
Surr: 4-Terphenyl-d14	47.90	0	50	0	95.8	47.7	133	0	0	0	
Surr: Nitrobenzene-d5	35.95	0	50	0	71.9	45.7	120	0	0	0	

Qualifiers:
» Greater than Result value
« Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164270

Sample ID: 1207D55-016CMS	Client ID:	Units: ug/L	Prep Date: 07/25/2012	Run No: 225809
SampleType: MS	TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D	BatchID: 164270	Analysis Date: 07/26/2012	Seq No: 4728335

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Surr: Phenol-d5	58.45	0	100	0	58.4	10.9	120	0	0	0	

Sample ID: 1207D55-016CMSD	Client ID:	Units: ug/L	Prep Date: 07/25/2012	Run No: 225809
SampleType: MSD	TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D	BatchID: 164270	Analysis Date: 07/26/2012	Seq No: 4728336

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	72.30	50	100	0	72.3	54.4	120	68.85	4.89	25.5	
2-Chlorophenol	75.55	50	100	0	75.6	56.6	120	74.65	1.2	26.2	
4-Chloro-3-methylphenol	90.80	50	100	0	90.8	49.8	120	0	200	62.9	R
4-Nitrophenol	BRL	130	100	0	77.9	22	120	85.80	0	31.4	
Acenaphthene	431.8	50	100	491.6	-59.8	57.8	120	401.4	7.27	24.7	S
N-Nitrosodi-n-propylamine	BRL	50	100	0	0	60.7	124	0	0	28.2	S
Pentachlorophenol	166.8	130	100	113.8	53	37.6	130	160.4	3.91	26.6	
Phenol	2394	50	100	2390	3.75	27.9	120	2283	4.76	29.5	SE
Pyrene	137.0	50	100	86.05	51	57.9	118	130.3	5.01	24.4	S
Surr: 2,4,6-Tribromophenol	83.15	0	100	0	83.2	47.4	146	80.95	0	0	
Surr: 2-Fluorobiphenyl	37.90	0	50	0	75.8	51.5	122	35.10	0	0	
Surr: 2-Fluorophenol	57.95	0	100	0	58	28.5	120	55.60	0	0	
Surr: 4-Terphenyl-d14	49.65	0	50	0	99.3	47.7	133	47.90	0	0	
Surr: Nitrobenzene-d5	37.45	0	50	0	74.9	45.7	120	35.95	0	0	
Surr: Phenol-d5	59.50	0	100	0	59.5	10.9	120	58.45	0	0	

Qualifiers:					
	> Greater than Result value	< Less than Result value	B	Analyte detected in the associated method blank
	BRL Below reporting limit	E Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
	J Estimated value detected below Reporting Limit	N Analyte not NELAC certified	R	RPD outside limits due to matrix
	Rpt Lim Reporting Limit	S Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164271

Sample ID: MB-164271 Client ID: Units: mg/L Prep Date: 07/26/2012 Run No: 225869
SampleType: MBLK TestCode: SEMIVOLATILES ORGANICS, TCLP SW1311/8270D BatchID: 164271 Analysis Date: 07/26/2012 Seq No: 4728071

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,4-Dichlorobenzene	BRL	0.10	0	0	0	0	0	0	0	0	
2,4,5-Trichlorophenol	BRL	0.10	0	0	0	0	0	0	0	0	
2,4,6-Trichlorophenol	BRL	0.10	0	0	0	0	0	0	0	0	
2,4-Dinitrotoluene	BRL	0.10	0	0	0	0	0	0	0	0	
Cresols, Total	BRL	0.10	0	0	0	0	0	0	0	0	
Hexachlorobenzene	BRL	0.10	0	0	0	0	0	0	0	0	
Hexachlorobutadiene	BRL	0.10	0	0	0	0	0	0	0	0	
Hexachloroethane	BRL	0.10	0	0	0	0	0	0	0	0	
m,p-Cresol	BRL	0.10	0	0	0	0	0	0	0	0	
Nitrobenzene	BRL	0.10	0	0	0	0	0	0	0	0	
o-Cresol	BRL	0.10	0	0	0	0	0	0	0	0	
Pentachlorophenol	BRL	0.50	0	0	0	0	0	0	0	0	
Pyridine	BRL	0.10	0	0	0	0	0	0	0	0	
Surr: 2,4,6-Tribromophenol	0.9266	0	1	0	92.7	48.3	142	0	0	0	
Surr: 2-Fluorobiphenyl	0.4805	0	0.5	0	96.1	52.2	126	0	0	0	
Surr: 2-Fluorophenol	0.8474	0	1	0	84.7	42.4	125	0	0	0	
Surr: 4-Terphenyl-d14	0.5590	0	0.5	0	112	47	140	0	0	0	
Surr: Nitrobenzene-d5	0.4306	0	0.5	0	86.1	47.3	129	0	0	0	
Surr: Phenol-d5	0.8203	0	1	0	82	40.3	124	0	0	0	

Sample ID: LCS-164271 Client ID: Units: mg/L Prep Date: 07/26/2012 Run No: 225869
SampleType: LCS TestCode: SEMIVOLATILES ORGANICS, TCLP SW1311/8270D BatchID: 164271 Analysis Date: 07/26/2012 Seq No: 4728073

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,4-Dichlorobenzene	0.8453	0.10	1	0	84.5	66.8	120	0	0	0	
2,4,5-Trichlorophenol	0.7705	0.10	1	0	77	70.6	126	0	0	0	
2,4,6-Trichlorophenol	0.9020	0.10	1	0	90.2	77.9	121	0	0	0	
2,4-Dinitrotoluene	0.8898	0.10	1	0	89	72.6	116	0	0	0	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

Date: 30-Jul-12

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164271

Sample ID: LCS-164271 Client ID:
SampleType: LCS TestCode: SEMIVOLATILES ORGANICS, TCLP SW1311/8270D
Units: mg/L Prep Date: 07/26/2012 Run No: 225869
BatchID: 164271 Analysis Date: 07/26/2012 Seq No: 4728073

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Cresols, Total	2.365	0.10	3	0	78.8	74.9	116	0	0	0	
Hexachlorobenzene	0.9804	0.10	1	0	98	82.2	122	0	0	0	
Hexachlorobutadiene	0.9732	0.10	1	0	97.3	55.8	116	0	0	0	
Hexachloroethane	0.8211	0.10	1	0	82.1	60.1	116	0	0	0	
m,p-Cresol	1.527	0.10	2	0	76.3	74.4	116	0	0	0	
Nitrobenzene	0.8691	0.10	1	0	86.9	71.1	122	0	0	0	
o-Cresol	0.8381	0.10	1	0	83.8	75	116	0	0	0	
Pentachlorophenol	0.6445	0.50	1	0	64.4	52.9	123	0	0	0	
Pyridine	0.1544	0.10	1	0	15.4	10	120	0	0	0	
Surr: 2,4,6-Tribromophenol	0.9776	0	1	0	97.8	48.3	142	0	0	0	
Surr: 2-Fluorobiphenyl	0.4731	0	0.5	0	94.6	52.2	126	0	0	0	
Surr: 2-Fluorophenol	0.8207	0	1	0	82.1	42.4	125	0	0	0	
Surr: 4-Terphenyl-d14	0.5598	0	0.5	0	112	47	140	0	0	0	
Surr: Nitrobenzene-d5	0.4224	0	0.5	0	84.5	47.3	129	0	0	0	
Surr: Phenol-d5	0.8088	0	1	0	80.9	40.3	124	0	0	0	

Sample ID: 1207C63-011CMS Client ID:
SampleType: MS TestCode: SEMIVOLATILES ORGANICS, TCLP SW1311/8270D
Units: mg/L Prep Date: 07/26/2012 Run No: 225869
BatchID: 164271 Analysis Date: 07/26/2012 Seq No: 4728076

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,4-Dichlorobenzene	0.8629	0.10	1	0	86.3	51.3	120	0	0	0	
2,4,5-Trichlorophenol	0.7160	0.10	1	0	71.6	61.4	123	0	0	0	
2,4,6-Trichlorophenol	0.9227	0.10	1	0	92.3	63.1	123	0	0	0	
2,4-Dinitrotoluene	0.8835	0.10	1	0	88.4	50.1	124	0	0	0	
Cresols, Total	2.395	0.10	3	0	79.8	62.2	114	0	0	0	
Hexachlorobenzene	1.008	0.10	1	0	101	56.5	127	0	0	0	
Hexachlorobutadiene	0.9963	0.10	1	0	99.6	46	112	0	0	0	
Hexachloroethane	0.8334	0.10	1	0	83.3	45.6	114	0	0	0	

Qualifiers:
> Greater than Result value
BRL Below reporting limit
J Estimated value detected below Reporting Limit
Rpt Lim Reporting Limit
< Less than Result value
E Estimated (value above quantitation range)
N Analyte not NELAC certified
S Spike Recovery outside limits due to matrix
B Analyte detected in the associated method blank
H Holding times for preparation or analysis exceeded
R RPD outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164271

Sample ID: **1207C63-011CMS** Client ID: Units: **mg/L** Prep Date: **07/26/2012** Run No: **225869**
SampleType: **MS** TestCode: **SEMIVOLATILES ORGANICS, TCLP SW1311/8270D** BatchID: **164271** Analysis Date: **07/26/2012** Seq No: **4728076**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
m,p-Cresol	1.543	0.10	2	0	77.2	61.9	115	0	0	0	
Nitrobenzene	0.8876	0.10	1	0	88.8	56.8	121	0	0	0	
o-Cresol	0.8515	0.10	1	0	85.2	58.7	117	0	0	0	
Pentachlorophenol	BRL	0.50	1	0	37.9	42.9	129	0	0	0	S
Pyridine	0.1073	0.10	1	0	10.7	10	120	0	0	0	
Surr: 2,4,6-Tribromophenol	0.9812	0	1	0	98.1	48.3	142	0	0	0	
Surr: 2-Fluorobiphenyl	0.4900	0	0.5	0	98	52.2	126	0	0	0	
Surr: 2-Fluorophenol	0.8506	0	1	0	85.1	42.4	125	0	0	0	
Surr: 4-Terphenyl-d14	0.5687	0	0.5	0	114	47	140	0	0	0	
Surr: Nitrobenzene-d5	0.4266	0	0.5	0	85.3	47.3	129	0	0	0	
Surr: Phenol-d5	0.8155	0	1	0	81.6	40.3	124	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164273

Sample ID: **MB-164273** Client ID:
SampleType: **MBLK** TestCode: **TCL-SEMIVOLATILE ORGANICS SW8270D**
Units: **ug/Kg** Prep Date: **07/26/2012** Run No: **225870**
BatchID: **164273** Analysis Date: **07/26/2012** Seq No: **4728092**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1'-Biphenyl	BRL	330	0	0	0	0	0	0	0	0	
2,4,5-Trichlorophenol	BRL	1700	0	0	0	0	0	0	0	0	
2,4,6-Trichlorophenol	BRL	330	0	0	0	0	0	0	0	0	
2,4-Dichlorophenol	BRL	330	0	0	0	0	0	0	0	0	
2,4-Dimethylphenol	BRL	330	0	0	0	0	0	0	0	0	
2,4-Dinitrophenol	BRL	1700	0	0	0	0	0	0	0	0	
2,4-Dinitrotoluene	BRL	330	0	0	0	0	0	0	0	0	
2,6-Dinitrotoluene	BRL	330	0	0	0	0	0	0	0	0	
2-Chloronaphthalene	BRL	330	0	0	0	0	0	0	0	0	
2-Chlorophenol	BRL	330	0	0	0	0	0	0	0	0	
2-Methylnaphthalene	BRL	330	0	0	0	0	0	0	0	0	
2-Methylphenol	BRL	330	0	0	0	0	0	0	0	0	
2-Nitroaniline	BRL	1700	0	0	0	0	0	0	0	0	
2-Nitrophenol	BRL	330	0	0	0	0	0	0	0	0	
3,3'-Dichlorobenzidine	BRL	670	0	0	0	0	0	0	0	0	
3-Nitroaniline	BRL	1700	0	0	0	0	0	0	0	0	
4,6-Dinitro-2-methylphenol	BRL	1700	0	0	0	0	0	0	0	0	
4-Bromophenyl phenyl ether	BRL	330	0	0	0	0	0	0	0	0	
4-Chloro-3-methylphenol	BRL	330	0	0	0	0	0	0	0	0	
4-Chloroaniline	BRL	330	0	0	0	0	0	0	0	0	
4-Chlorophenyl phenyl ether	BRL	330	0	0	0	0	0	0	0	0	
4-Methylphenol	BRL	330	0	0	0	0	0	0	0	0	
4-Nitroaniline	BRL	1700	0	0	0	0	0	0	0	0	
4-Nitrophenol	BRL	1700	0	0	0	0	0	0	0	0	
Acenaphthene	BRL	330	0	0	0	0	0	0	0	0	
Acenaphthylene	BRL	330	0	0	0	0	0	0	0	0	
Acetophenone	BRL	330	0	0	0	0	0	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164273

Sample ID: MB-164273 Client ID: Units: ug/Kg Prep Date: 07/26/2012 Run No: 225870
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D BatchID: 164273 Analysis Date: 07/26/2012 Seq No: 4728092

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Anthracene	BRL	330	0	0	0	0	0	0	0	0	
Atrazine	BRL	330	0	0	0	0	0	0	0	0	
Benz(a)anthracene	BRL	330	0	0	0	0	0	0	0	0	
Benzaldehyde	BRL	330	0	0	0	0	0	0	0	0	
Benzo(a)pyrene	BRL	330	0	0	0	0	0	0	0	0	
Benzo(b)fluoranthene	BRL	330	0	0	0	0	0	0	0	0	
Benzo(g,h,i)perylene	BRL	330	0	0	0	0	0	0	0	0	
Benzo(k)fluoranthene	BRL	330	0	0	0	0	0	0	0	0	
Bis(2-chloroethoxy)methane	BRL	330	0	0	0	0	0	0	0	0	
Bis(2-chloroethyl)ether	BRL	330	0	0	0	0	0	0	0	0	
Bis(2-chloroisopropyl)ether	BRL	330	0	0	0	0	0	0	0	0	
Bis(2-ethylhexyl)phthalate	BRL	330	0	0	0	0	0	0	0	0	
Butyl benzyl phthalate	BRL	330	0	0	0	0	0	0	0	0	
Caprolactam	BRL	330	0	0	0	0	0	0	0	0	
Carbazole	BRL	330	0	0	0	0	0	0	0	0	
Chrysene	BRL	330	0	0	0	0	0	0	0	0	
Di-n-butyl phthalate	BRL	330	0	0	0	0	0	0	0	0	
Di-n-octyl phthalate	BRL	330	0	0	0	0	0	0	0	0	
Dibenz(a,h)anthracene	BRL	330	0	0	0	0	0	0	0	0	
Dibenzofuran	BRL	330	0	0	0	0	0	0	0	0	
Diethyl phthalate	BRL	330	0	0	0	0	0	0	0	0	
Dimethyl phthalate	BRL	330	0	0	0	0	0	0	0	0	
Fluoranthene	BRL	330	0	0	0	0	0	0	0	0	
Fluorene	BRL	330	0	0	0	0	0	0	0	0	
Hexachlorobenzene	BRL	330	0	0	0	0	0	0	0	0	
Hexachlorobutadiene	BRL	330	0	0	0	0	0	0	0	0	
Hexachlorocyclopentadiene	BRL	660	0	0	0	0	0	0	0	0	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164273

Sample ID: MB-164273 Client ID:
SampleType: MBLK TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/Kg Prep Date: 07/26/2012 Run No: 225870
BatchID: 164273 Analysis Date: 07/26/2012 Seq No: 4728092

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Hexachloroethane	BRL	330	0	0	0	0	0	0	0	0	
Indeno(1,2,3-cd)pyrene	BRL	330	0	0	0	0	0	0	0	0	
Isophorone	BRL	330	0	0	0	0	0	0	0	0	
N-Nitrosodi-n-propylamine	BRL	330	0	0	0	0	0	0	0	0	
N-Nitrosodiphenylamine	BRL	330	0	0	0	0	0	0	0	0	
Naphthalene	BRL	330	0	0	0	0	0	0	0	0	
Nitrobenzene	BRL	330	0	0	0	0	0	0	0	0	
Pentachlorophenol	BRL	1700	0	0	0	0	0	0	0	0	
Phenanthrene	BRL	330	0	0	0	0	0	0	0	0	
Phenol	BRL	330	0	0	0	0	0	0	0	0	
Pyrene	BRL	330	0	0	0	0	0	0	0	0	
Surr: 2,4,6-Tribromophenol	3144	0	3333	0	94.3	41.1	130	0	0	0	
Surr: 2-Fluorobiphenyl	1566	0	1667	0	94	45	120	0	0	0	
Surr: 2-Fluorophenol	2631	0	3333	0	78.9	35	120	0	0	0	
Surr: 4-Terphenyl-d14	1988	0	1667	0	119	50.1	123	0	0	0	
Surr: Nitrobenzene-d5	1340	0	1667	0	80.4	37.5	120	0	0	0	
Surr: Phenol-d5	2647	0	3333	0	79.4	39	120	0	0	0	

Sample ID: LCS-164273 Client ID:
SampleType: LCS TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D
Units: ug/Kg Prep Date: 07/26/2012 Run No: 225870
BatchID: 164273 Analysis Date: 07/26/2012 Seq No: 4728093

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	3063	330	3333	0	91.9	57.6	120	0	0	0	
2-Chlorophenol	2730	330	3333	0	81.9	59	120	0	0	0	
4-Chloro-3-methylphenol	3013	330	3333	0	90.4	55.1	120	0	0	0	
4-Nitrophenol	1841	1700	3333	0	55.2	40	116	0	0	0	
Acenaphthene	2953	330	3333	0	88.6	59	120	0	0	0	
N-Nitrosodi-n-propylamine	2673	330	3333	0	80.2	59.4	120	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164273

Sample ID: LCS-164273 Client ID: Units: ug/Kg Prep Date: 07/26/2012 Run No: 225870
SampleType: LCS TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D BatchID: 164273 Analysis Date: 07/26/2012 Seq No: 4728093

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Pentachlorophenol	2155	1700	3333	0	64.7	44.6	120	0	0	0	
Phenol	2395	330	3333	0	71.9	55.1	120	0	0	0	
Pyrene	3406	330	3333	0	102	62.8	123	0	0	0	
Surr: 2,4,6-Tribromophenol	3689	0	3333	0	111	41.1	130	0	0	0	
Surr: 2-Fluorobiphenyl	1651	0	1667	0	99.1	45	120	0	0	0	
Surr: 2-Fluorophenol	2671	0	3333	0	80.1	35	120	0	0	0	
Surr: 4-Terphenyl-d14	2082	0	1667	0	125	50.1	123	0	0	0	S
Surr: Nitrobenzene-d5	1426	0	1667	0	85.6	37.5	120	0	0	0	
Surr: Phenol-d5	2689	0	3333	0	80.7	39	120	0	0	0	

Sample ID: 1207H10-008CMS Client ID: TP-4@6 Units: ug/Kg-dry Prep Date: 07/26/2012 Run No: 225870
SampleType: MS TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D BatchID: 164273 Analysis Date: 07/26/2012 Seq No: 4728100

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	3655	420	4282	0	85.4	40.3	120	0	0	0	
2-Chlorophenol	3056	420	4282	0	71.4	44.8	120	0	0	0	
4-Chloro-3-methylphenol	3641	420	4282	0	85	45.1	120	0	0	0	
4-Nitrophenol	2213	2200	4282	0	51.7	30.4	120	0	0	0	
Acenaphthene	3537	420	4282	0	82.6	50.4	120	0	0	0	
N-Nitrosodi-n-propylamine	3079	420	4282	0	71.9	50.8	120	0	0	0	
Pentachlorophenol	2347	2200	4282	0	54.8	31.1	120	0	0	0	
Phenol	2727	420	4282	0	63.7	43.9	120	0	0	0	
Pyrene	4202	420	4282	0	98.1	47.9	115	0	0	0	
Surr: 2,4,6-Tribromophenol	4480	0	4282	0	105	41.1	130	0	0	0	
Surr: 2-Fluorobiphenyl	1935	0	2141	0	90.4	45	120	0	0	0	
Surr: 2-Fluorophenol	2908	0	4282	0	67.9	35	120	0	0	0	
Surr: 4-Terphenyl-d14	2524	0	2141	0	118	50.1	123	0	0	0	
Surr: Nitrobenzene-d5	1625	0	2141	0	75.9	37.5	120	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164273

Sample ID: 1207H10-008CMS	Client ID: TP-4@6	Units: ug/Kg-dry	Prep Date: 07/26/2012	Run No: 225870
SampleType: MS	TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D	BatchID: 164273	Analysis Date: 07/26/2012	Seq No: 4728100

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Surr: Phenol-d5	3035	0	4282	0	70.9	39	120	0	0	0	

Sample ID: 1207H10-008CMSD	Client ID: TP-4@6	Units: ug/Kg-dry	Prep Date: 07/26/2012	Run No: 225870
SampleType: MSD	TestCode: TCL-SEMIVOLATILE ORGANICS SW8270D	BatchID: 164273	Analysis Date: 07/27/2012	Seq No: 4728101

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2,4-Dinitrotoluene	3758	420	4282	0	87.8	40.3	120	3655	2.8	20.9	
2-Chlorophenol	3102	420	4282	0	72.5	44.8	120	3056	1.52	21.7	
4-Chloro-3-methylphenol	3738	420	4282	0	87.3	45.1	120	3641	2.65	23	
4-Nitrophenol	2357	2200	4282	0	55	30.4	120	2213	6.3	24.1	
Acenaphthene	3609	420	4282	0	84.3	50.4	120	3537	2.01	21.3	
N-Nitrosodi-n-propylamine	3209	420	4282	0	75	50.8	120	3079	4.15	20.4	
Pentachlorophenol	3013	2200	4282	0	70.4	31.1	120	2347	24.8	20.6	R
Phenol	2777	420	4282	0	64.9	43.9	120	2727	1.8	21	
Pyrene	4178	420	4282	0	97.6	47.9	115	4202	0.572	18.9	
Surr: 2,4,6-Tribromophenol	4672	0	4282	0	109	41.1	130	4480	0	0	
Surr: 2-Fluorobiphenyl	2061	0	2141	0	96.3	45	120	1935	0	0	
Surr: 2-Fluorophenol	3105	0	4282	0	72.5	35	120	2908	0	0	
Surr: 4-Terphenyl-d14	2618	0	2141	0	122	50.1	123	2524	0	0	
Surr: Nitrobenzene-d5	1709	0	2141	0	79.8	37.5	120	1625	0	0	
Surr: Phenol-d5	3191	0	4282	0	74.5	39	120	3035	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164332

Sample ID: MB-164332	Client ID:					Units: mg/Kg		Prep Date: 07/26/2012		Run No: 225825	
SampleType: MBLK	TestCode: TOTAL MERCURY SW7471B					BatchID: 164332		Analysis Date: 07/26/2012		Seq No: 4726941	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	BRL	0.100	0	0	0	0	0	0	0	0	

Sample ID: LCS-164332	Client ID:					Units: mg/Kg		Prep Date: 07/26/2012		Run No: 225825	
SampleType: LCS	TestCode: TOTAL MERCURY SW7471B					BatchID: 164332		Analysis Date: 07/26/2012		Seq No: 4726942	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.4048	0.100	0.4	0	101	80	120	0	0	0	

Sample ID: 1207H08-025AMS	Client ID:					Units: mg/Kg-dry		Prep Date: 07/26/2012		Run No: 225825	
SampleType: MS	TestCode: TOTAL MERCURY SW7471B					BatchID: 164332		Analysis Date: 07/26/2012		Seq No: 4726944	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.5463	0.120	0.4807	0.05120	103	70	130	0	0	0	

Sample ID: 1207H08-025AMSD	Client ID:					Units: mg/Kg-dry		Prep Date: 07/26/2012		Run No: 225825	
SampleType: MSD	TestCode: TOTAL MERCURY SW7471B					BatchID: 164332		Analysis Date: 07/26/2012		Seq No: 4726945	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Mercury	0.5517	0.120	0.4807	0.05120	104	70	130	0.5463	0.974	30	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164343

Sample ID: **MB-164343** Client ID:
SampleType: **MBLK** TestCode: **METALS, TOTAL** **SW6010C**
Units: **mg/Kg** Prep Date: **07/26/2012** Run No: **225865**
BatchID: **164343** Analysis Date: **07/27/2012** Seq No: **4728011**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	5.00	0	0	0	0	0	0	0	0	
Barium	BRL	5.00	0	0	0	0	0	0	0	0	
Cadmium	BRL	2.50	0	0	0	0	0	0	0	0	
Chromium	BRL	2.50	0	0	0	0	0	0	0	0	
Lead	BRL	5.00	0	0	0	0	0	0	0	0	
Selenium	BRL	5.00	0	0	0	0	0	0	0	0	
Silver	BRL	2.50	0	0	0	0	0	0	0	0	

Sample ID: **LCS-164343** Client ID:
SampleType: **LCS** TestCode: **METALS, TOTAL** **SW6010C**
Units: **mg/Kg** Prep Date: **07/26/2012** Run No: **225865**
BatchID: **164343** Analysis Date: **07/27/2012** Seq No: **4728010**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	44.49	5.00	50	0.2119	88.6	80	120	0	0	0	
Barium	51.07	5.00	50	0.1650	102	80	120	0	0	0	
Cadmium	48.39	2.50	50	0	96.8	80	120	0	0	0	
Chromium	49.43	2.50	50	0.1080	98.7	80	120	0	0	0	
Lead	46.43	5.00	50	0.2373	92.4	80	120	0	0	0	
Selenium	43.22	5.00	50	0	86.4	80	120	0	0	0	
Silver	4.775	2.50	5	0	95.5	80	120	0	0	0	

Sample ID: **1207H13-011AMS** Client ID:
SampleType: **MS** TestCode: **METALS, TOTAL** **SW6010C**
Units: **mg/Kg-dry** Prep Date: **07/26/2012** Run No: **225865**
BatchID: **164343** Analysis Date: **07/27/2012** Seq No: **4728013**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	28.15	4.95	49.47	0	56.9	75	125	0	0	0	S
Barium	88.49	4.95	49.47	65.33	46.8	75	125	0	0	0	S
Cadmium	38.27	2.47	49.47	0.1829	77	75	125	0	0	0	
Chromium	90.79	2.47	49.47	52.60	77.2	75	125	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164343

Sample ID: 1207H13-011AMS	Client ID:			Units: mg/Kg-dry	Prep Date: 07/26/2012	Run No: 225865
SampleType: MS	TestCode: METALS, TOTAL SW6010C			BatchID: 164343	Analysis Date: 07/27/2012	Seq No: 4728013

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	573.6	4.95	49.47	780.5	-418	75	125	0	0	0	S
Silver	BRL	2.47	4.947	0	0	75	125	0	0	0	S

Sample ID: 1207H13-011AMS	Client ID:			Units: mg/Kg-dry	Prep Date: 07/26/2012	Run No: 225865
SampleType: MS	TestCode: METALS, TOTAL SW6010C			BatchID: 164343	Analysis Date: 07/27/2012	Seq No: 4728650

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Selenium	BRL	24.7	49.47	0	17.5	75	125	0	0	0	S

Sample ID: 1207H13-011AMSD	Client ID:			Units: mg/Kg-dry	Prep Date: 07/26/2012	Run No: 225865
SampleType: MSD	TestCode: METALS, TOTAL SW6010C			BatchID: 164343	Analysis Date: 07/27/2012	Seq No: 4728014

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	27.87	4.92	49.24	0	56.6	75	125	28.15	1.01	20	S
Barium	90.44	4.92	49.24	65.33	51	75	125	88.49	2.18	20	S
Cadmium	38.41	2.46	49.24	0.1829	77.6	75	125	38.27	0.352	20	
Chromium	95.57	2.46	49.24	52.60	87.3	75	125	90.79	5.13	20	
Lead	671.7	4.92	49.24	780.5	-221	75	125	573.6	15.8	20	S
Silver	BRL	2.46	4.924	0	0	75	125	0	0	20	S

Sample ID: 1207H13-011AMSD	Client ID:			Units: mg/Kg-dry	Prep Date: 07/26/2012	Run No: 225865
SampleType: MSD	TestCode: METALS, TOTAL SW6010C			BatchID: 164343	Analysis Date: 07/27/2012	Seq No: 4728651

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Selenium	BRL	24.6	49.24	0	20.9	75	125	8.667	0	20	S

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164346

Sample ID: **MB-164346** Client ID:
SampleType: **MBLK** TestCode: **ICP METALS, TCLP SW1311/6010C**
Units: **mg/L** Prep Date: **07/26/2012** Run No: **225810**
BatchID: **164346** Analysis Date: **07/26/2012** Seq No: **4726767**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	BRL	0.250	0	0	0	0	0	0	0	0	
Barium	BRL	0.500	0	0	0	0	0	0	0	0	
Cadmium	BRL	0.0250	0	0	0	0	0	0	0	0	
Chromium	BRL	0.0500	0	0	0	0	0	0	0	0	
Lead	BRL	0.0500	0	0	0	0	0	0	0	0	
Selenium	BRL	0.100	0	0	0	0	0	0	0	0	
Silver	BRL	0.0250	0	0	0	0	0	0	0	0	

Sample ID: **LCS-164346** Client ID:
SampleType: **LCS** TestCode: **ICP METALS, TCLP SW1311/6010C**
Units: **mg/L** Prep Date: **07/26/2012** Run No: **225810**
BatchID: **164346** Analysis Date: **07/26/2012** Seq No: **4726766**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.548	0.250	5	0	111	85	115	0	0	0	
Barium	5.022	0.500	5	0.01296	100	80	120	0	0	0	
Cadmium	5.232	0.0250	5	0	105	85	115	0	0	0	
Chromium	5.342	0.0500	5	0	107	85	115	0	0	0	
Lead	5.178	0.0500	5	0	104	85	115	0	0	0	
Selenium	5.557	0.100	5	0.03716	110	85	115	0	0	0	
Silver	0.5048	0.0250	0.5	0	101	85	115	0	0	0	

Sample ID: **1207G83-001AMS** Client ID:
SampleType: **MS** TestCode: **ICP METALS, TCLP SW1311/6010C**
Units: **mg/L** Prep Date: **07/26/2012** Run No: **225810**
BatchID: **164346** Analysis Date: **07/26/2012** Seq No: **4726769**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.492	0.250	5	0	110	50	150	0	0	0	
Barium	6.669	0.500	5	1.673	99.9	50	150	0	0	0	
Cadmium	5.173	0.0250	5	0	103	50	150	0	0	0	
Chromium	5.229	0.0500	5	0.01066	104	50	150	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164346

Sample ID: 1207G83-001AMS	Client ID:			Units: mg/L	Prep Date: 07/26/2012	Run No: 225810
SampleType: MS	TestCode: ICP METALS, TCLP SW1311/6010C			BatchID: 164346	Analysis Date: 07/26/2012	Seq No: 4726769

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	6.513	0.0500	5	1.420	102	50	150	0	0	0	
Selenium	5.458	0.100	5	0	109	50	150	0	0	0	
Silver	0.5003	0.0250	0.5	0.003260	99.4	50	150	0	0	0	

Sample ID: 1207G83-001AMSD	Client ID:			Units: mg/L	Prep Date: 07/26/2012	Run No: 225810
SampleType: MSD	TestCode: ICP METALS, TCLP SW1311/6010C			BatchID: 164346	Analysis Date: 07/26/2012	Seq No: 4726770

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Arsenic	5.549	0.250	5	0	111	50	150	5.492	1.03	30	
Barium	6.699	0.500	5	1.673	101	50	150	6.669	0.445	30	
Cadmium	5.218	0.0250	5	0	104	50	150	5.173	0.854	30	
Chromium	5.303	0.0500	5	0.01066	106	50	150	5.229	1.41	30	
Lead	6.553	0.0500	5	1.420	103	50	150	6.513	0.609	30	
Selenium	5.602	0.100	5	0	112	50	150	5.458	2.6	30	
Silver	0.5059	0.0250	0.5	0.003260	101	50	150	0.5003	1.12	30	

Qualifiers:					
	> Greater than Result value	< Less than Result value	B Analyte detected in the associated method blank		
	BRL Below reporting limit	E Estimated (value above quantitation range)	H Holding times for preparation or analysis exceeded		
	J Estimated value detected below Reporting Limit	N Analyte not NELAC certified	R RPD outside limits due to matrix		
	Rpt Lim Reporting Limit	S Spike Recovery outside limits due to matrix			

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164362

Sample ID: MB-164362	Client ID:					Units: mg/L		Prep Date: 07/27/2012		Run No: 225895
SampleType: MBLK	TestCode: MERCURY, TCLP SW1311/7470A					BatchID: 164362		Analysis Date: 07/27/2012		Seq No: 4728599
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
Mercury	BRL	0.00400	0	0	0	0	0	0	0	0

Sample ID: LCS-164362	Client ID:					Units: mg/L		Prep Date: 07/27/2012		Run No: 225895
SampleType: LCS	TestCode: MERCURY, TCLP SW1311/7470A					BatchID: 164362		Analysis Date: 07/27/2012		Seq No: 4728600
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
Mercury	0.04008	0.00400	0.04	0	100	80	120	0	0	0

Sample ID: 1207H10-011AMS	Client ID: TP-1TO 4					Units: mg/L		Prep Date: 07/27/2012		Run No: 225895
SampleType: MS	TestCode: MERCURY, TCLP SW1311/7470A					BatchID: 164362		Analysis Date: 07/27/2012		Seq No: 4728631
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
Mercury	0.03902	0.00400	0.04	0	97.5	80	120	0	0	0

Sample ID: 1207H10-011AMSD	Client ID: TP-1TO 4					Units: mg/L		Prep Date: 07/27/2012		Run No: 225895
SampleType: MSD	TestCode: MERCURY, TCLP SW1311/7470A					BatchID: 164362		Analysis Date: 07/27/2012		Seq No: 4728633
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
Mercury	0.03888	0.00400	0.04	0	97.2	80	120	0.03902	0.36	20

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164385

Sample ID: MB-164385 Client ID: Units: ug/L Prep Date: 07/26/2012 Run No: 225859
SampleType: MBLK TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164385 Analysis Date: 07/26/2012 Seq No: 4727891

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2,2-Tetrachloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2,4-Trichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromo-3-chloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromoethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,3-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,4-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
2-Butanone	BRL	50	0	0	0	0	0	0	0	0	
2-Hexanone	BRL	10	0	0	0	0	0	0	0	0	
4-Methyl-2-pentanone	BRL	10	0	0	0	0	0	0	0	0	
Acetone	BRL	50	0	0	0	0	0	0	0	0	
Benzene	BRL	5.0	0	0	0	0	0	0	0	0	
Bromodichloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Bromoform	BRL	5.0	0	0	0	0	0	0	0	0	
Bromomethane	BRL	5.0	0	0	0	0	0	0	0	0	
Carbon disulfide	BRL	5.0	0	0	0	0	0	0	0	0	
Carbon tetrachloride	BRL	5.0	0	0	0	0	0	0	0	0	
Chlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Chloroethane	BRL	10	0	0	0	0	0	0	0	0	
Chloroform	BRL	5.0	0	0	0	0	0	0	0	0	
Chloromethane	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value
BRL	Below reporting limit	E	Estimated (value above quantitation range)
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix

B	Analyte detected in the associated method blank
H	Holding times for preparation or analysis exceeded
R	RPD outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164385

Sample ID: **MB-164385** Client ID:
SampleType: **MBLK** TestCode: **TCL VOLATILE ORGANICS SW8260B**
Units: **ug/L** Prep Date: **07/26/2012** Run No: **225859**
BatchID: **164385** Analysis Date: **07/26/2012** Seq No: **4727891**

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
cis-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
cis-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Cyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Dibromochloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Dichlorodifluoromethane	BRL	10	0	0	0	0	0	0	0	0	
Ethylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Freon-113	BRL	10	0	0	0	0	0	0	0	0	
Isopropylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
m,p-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl acetate	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl tert-butyl ether	BRL	5.0	0	0	0	0	0	0	0	0	
Methylcyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Methylene chloride	BRL	5.0	0	0	0	0	0	0	0	0	
o-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Styrene	BRL	5.0	0	0	0	0	0	0	0	0	
Tetrachloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Toluene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichlorofluoromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Vinyl chloride	BRL	2.0	0	0	0	0	0	0	0	0	
Surr: 4-Bromofluorobenzene	43.31	0	50	0	86.6	67.4	123	0	0	0	
Surr: Dibromofluoromethane	51.32	0	50	0	103	75.5	128	0	0	0	
Surr: Toluene-d8	46.38	0	50	0	92.8	70	120	0	0	0	

Qualifiers:	>	Greater than Result value	<	Less than Result value	B Analyte detected in the associated method blank
	BRL	Below reporting limit	E	Estimated (value above quantitation range)	H Holding times for preparation or analysis exceeded
	J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R RPD outside limits due to matrix
	Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix	

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164385

Sample ID: LCS-164385 Client ID: Units: ug/L Prep Date: 07/26/2012 Run No: 225863
SampleType: LCS TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164385 Analysis Date: 07/27/2012 Seq No: 4729234

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	41.17	5.0	50	0	82.3	60	140	0	0	0	
Benzene	51.90	5.0	50	0	104	70	130	0	0	0	
Chlorobenzene	46.21	5.0	50	0	92.4	70	130	0	0	0	
Toluene	50.64	5.0	50	0	101	70	130	0	0	0	
Trichloroethene	47.13	5.0	50	0	94.3	70	130	0	0	0	
Surr: 4-Bromofluorobenzene	50.96	0	50	0	102	67.4	123	0	0	0	
Surr: Dibromofluoromethane	50.06	0	50	0	100	75.5	128	0	0	0	
Surr: Toluene-d8	51.67	0	50	0	103	70	120	0	0	0	

Sample ID: 1207G23-001AMS Client ID: Units: ug/L Prep Date: 07/26/2012 Run No: 225859
SampleType: MS TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164385 Analysis Date: 07/27/2012 Seq No: 4727811

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	75.16	5.0	50	0	150	50.1	179	0	0	0	
Benzene	73.72	5.0	50	0	147	61.2	150	0	0	0	
Chlorobenzene	62.56	5.0	50	0	125	72.1	140	0	0	0	
Toluene	69.79	5.0	50	0	140	58.7	154	0	0	0	
Trichloroethene	68.17	5.0	50	0	136	68.3	149	0	0	0	
Surr: 4-Bromofluorobenzene	52.79	0	50	0	106	67.4	123	0	0	0	
Surr: Dibromofluoromethane	50.41	0	50	0	101	75.5	128	0	0	0	
Surr: Toluene-d8	48.70	0	50	0	97.4	70	120	0	0	0	

Sample ID: 1207G23-001AMSD Client ID: Units: ug/L Prep Date: 07/26/2012 Run No: 225859
SampleType: MSD TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164385 Analysis Date: 07/27/2012 Seq No: 4727812

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	64.13	5.0	50	0	128	50.1	179	75.16	15.8	23.3	
Benzene	71.16	5.0	50	0	142	61.2	150	73.72	3.53	19	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Analytical Environmental Services, Inc

Date: 30-Jul-12

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164385

Sample ID: 1207G23-001AMSD Client ID: Units: ug/L Prep Date: 07/26/2012 Run No: 225859
SampleType: MSD TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164385 Analysis Date: 07/27/2012 Seq No: 4727812

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Chlorobenzene	60.54	5.0	50	0	121	72.1	140	62.56	3.28	21.5	
Toluene	69.25	5.0	50	0	138	58.7	154	69.79	0.777	20	
Trichloroethene	68.31	5.0	50	0	137	68.3	149	68.17	0.205	17.7	
Surr: 4-Bromofluorobenzene	51.87	0	50	0	104	67.4	123	52.79	0	0	
Surr: Dibromofluoromethane	48.97	0	50	0	97.9	75.5	128	50.41	0	0	
Surr: Toluene-d8	47.48	0	50	0	95	70	120	48.70	0	0	

Qualifiers:
- > Greater than Result value
- BRL Below reporting limit
- J Estimated value detected below Reporting Limit
- Rpt Lim Reporting Limit
- < Less than Result value
- E Estimated (value above quantitation range)
- N Analyte not NELAC certified
- S Spike Recovery outside limits due to matrix
- B Analyte detected in the associated method blank
- H Holding times for preparation or analysis exceeded
- R RPD outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164405

Sample ID: MB-164405 Client ID: Units: ug/Kg Prep Date: 07/26/2012 Run No: 225890
SampleType: MBLK TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164405 Analysis Date: 07/26/2012 Seq No: 4728482

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1,1-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2,2-Tetrachloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1,2-Trichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,1-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2,4-Trichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromo-3-chloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dibromoethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloroethane	BRL	5.0	0	0	0	0	0	0	0	0	
1,2-Dichloropropane	BRL	5.0	0	0	0	0	0	0	0	0	
1,3-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
1,4-Dichlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
2-Butanone	BRL	50	0	0	0	0	0	0	0	0	
2-Hexanone	BRL	10	0	0	0	0	0	0	0	0	
4-Methyl-2-pentanone	BRL	10	0	0	0	0	0	0	0	0	
Acetone	BRL	100	0	0	0	0	0	0	0	0	
Benzene	BRL	5.0	0	0	0	0	0	0	0	0	
Bromodichloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Bromoform	BRL	5.0	0	0	0	0	0	0	0	0	
Bromomethane	BRL	5.0	0	0	0	0	0	0	0	0	
Carbon disulfide	BRL	10	0	0	0	0	0	0	0	0	
Carbon tetrachloride	BRL	5.0	0	0	0	0	0	0	0	0	
Chlorobenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Chloroethane	BRL	10	0	0	0	0	0	0	0	0	
Chloroform	BRL	5.0	0	0	0	0	0	0	0	0	
Chloromethane	BRL	10	0	0	0	0	0	0	0	0	

Qualifiers:
> Greater than Result value
< Less than Result value
B Analyte detected in the associated method blank
BRL Below reporting limit
E Estimated (value above quantitation range)
H Holding times for preparation or analysis exceeded
J Estimated value detected below Reporting Limit
N Analyte not NELAC certified
R RPD outside limits due to matrix
Rpt Lim Reporting Limit
S Spike Recovery outside limits due to matrix

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164405

Sample ID: MB-164405 Client ID: Units: ug/Kg Prep Date: 07/26/2012 Run No: 225890
SampleType: MBLK TestCode: TCL VOLATILE ORGANICS SW8260B BatchID: 164405 Analysis Date: 07/26/2012 Seq No: 4728482

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
cis-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
cis-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Cyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Dibromochloromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Dichlorodifluoromethane	BRL	10	0	0	0	0	0	0	0	0	
Ethylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
Freon-113	BRL	10	0	0	0	0	0	0	0	0	
Isopropylbenzene	BRL	5.0	0	0	0	0	0	0	0	0	
m,p-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl acetate	BRL	5.0	0	0	0	0	0	0	0	0	
Methyl tert-butyl ether	BRL	5.0	0	0	0	0	0	0	0	0	
Methylcyclohexane	BRL	5.0	0	0	0	0	0	0	0	0	
Methylene chloride	BRL	5.0	0	0	0	0	0	0	0	0	
o-Xylene	BRL	5.0	0	0	0	0	0	0	0	0	
Styrene	BRL	5.0	0	0	0	0	0	0	0	0	
Tetrachloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Toluene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,2-Dichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
trans-1,3-Dichloropropene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichloroethene	BRL	5.0	0	0	0	0	0	0	0	0	
Trichlorofluoromethane	BRL	5.0	0	0	0	0	0	0	0	0	
Vinyl chloride	BRL	10	0	0	0	0	0	0	0	0	
Surr: 4-Bromofluorobenzene	50.04	0	50	0	100	56.5	134	0	0	0	
Surr: Dibromofluoromethane	48.26	0	50	0	96.5	71.8	135	0	0	0	
Surr: Toluene-d8	47.73	0	50	0	95.5	77.1	117	0	0	0	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164405

Sample ID: LCS-164405	Client ID:				Units: ug/Kg		Prep Date: 07/26/2012		Run No: 225890	
SampleType: LCS	TestCode: TCL VOLATILE ORGANICS SW8260B				BatchID: 164405		Analysis Date: 07/26/2012		Seq No: 4728483	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
1,1-Dichloroethene	63.58	5.0	50	0	127	60	140	0	0	0
Benzene	60.52	5.0	50	0	121	70	130	0	0	0
Chlorobenzene	58.77	5.0	50	0	118	70	130	0	0	0
Toluene	60.75	5.0	50	0	122	70	130	0	0	0
Trichloroethene	62.99	5.0	50	0	126	70	130	0	0	0
Surr: 4-Bromofluorobenzene	50.00	0	50	0	100	56.5	134	0	0	0
Surr: Dibromofluoromethane	48.76	0	50	0	97.5	71.8	135	0	0	0
Surr: Toluene-d8	48.50	0	50	0	97	77.1	117	0	0	0

Sample ID: 1207H67-007AMS	Client ID:				Units: ug/Kg		Prep Date: 07/26/2012		Run No: 225890	
SampleType: MS	TestCode: TCL VOLATILE ORGANICS SW8260B				BatchID: 164405		Analysis Date: 07/26/2012		Seq No: 4728532	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
1,1-Dichloroethene	57.53	5.0	50	0	115	51	159	0	0	0
Benzene	53.88	5.0	50	0	108	67.6	139	0	0	0
Chlorobenzene	49.11	5.0	50	0	98.2	73.6	135	0	0	0
Toluene	53.48	5.0	50	0	107	63.5	140	0	0	0
Trichloroethene	53.24	5.0	50	0	106	67.6	145	0	0	0
Surr: 4-Bromofluorobenzene	50.92	0	50	0	102	56.5	134	0	0	0
Surr: Dibromofluoromethane	49.03	0	50	0	98.1	71.8	135	0	0	0
Surr: Toluene-d8	49.13	0	50	0	98.3	77.1	117	0	0	0

Sample ID: 1207H67-007AMSD	Client ID:				Units: ug/Kg		Prep Date: 07/26/2012		Run No: 225890	
SampleType: MSD	TestCode: TCL VOLATILE ORGANICS SW8260B				BatchID: 164405		Analysis Date: 07/26/2012		Seq No: 4728534	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
1,1-Dichloroethene	55.35	5.0	50	0	111	51	159	57.53	3.86	25.7
Benzene	51.86	5.0	50	0	104	67.6	139	53.88	3.82	18.5

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Analytical Environmental Services, Inc

Date: 30-Jul-12

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164405

Sample ID: **1207H67-007AMSD**	Client ID:				Units: **ug/Kg**		Prep Date: **07/26/2012**		Run No: **225890**	
SampleType: **MSD**	TestCode: **TCL VOLATILE ORGANICS SW8260B**				BatchID: **164405**		Analysis Date: **07/26/2012**		Seq No: **4728534**	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit Qual
Chlorobenzene	48.53	5.0	50	0	97.1	73.6	135	49.11	1.19	18.5
Toluene	49.16	5.0	50	0	98.3	63.5	140	53.48	8.42	18.8
Trichloroethene	52.22	5.0	50	0	104	67.6	145	53.24	1.93	20.7
Surr: 4-Bromofluorobenzene	52.80	0	50	0	106	56.5	134	50.92	0	0
Surr: Dibromofluoromethane	49.47	0	50	0	98.9	71.8	135	49.03	0	0
Surr: Toluene-d8	48.21	0	50	0	96.4	77.1	117	49.13	0	0

Qualifiers:	>	Greater than Result value	<	Less than Result value	B Analyte detected in the associated method blank
	BRL	Below reporting limit	E	Estimated (value above quantitation range)	H Holding times for preparation or analysis exceeded
	J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R RPD outside limits due to matrix
	Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix	

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164411

Sample ID: MB-164411	Client ID:	Units: mg/L	Prep Date: 07/27/2012	Run No: 225879
SampleType: MBLK	TestCode: VOLATILES, TCLP SW1311/8260B	BatchID: 164411	Analysis Date: 07/27/2012	Seq No: 4728553

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	BRL	0.10	0	0	0	0	0	0	0	0	
1,2-Dichloroethane	BRL	0.10	0	0	0	0	0	0	0	0	
2-Butanone	BRL	0.20	0	0	0	0	0	0	0	0	
Benzene	BRL	0.10	0	0	0	0	0	0	0	0	
Carbon tetrachloride	BRL	0.10	0	0	0	0	0	0	0	0	
Chlorobenzene	BRL	0.10	0	0	0	0	0	0	0	0	
Chloroform	BRL	0.10	0	0	0	0	0	0	0	0	
Tetrachloroethene	BRL	0.10	0	0	0	0	0	0	0	0	
Trichloroethene	BRL	0.10	0	0	0	0	0	0	0	0	
Vinyl chloride	BRL	0.040	0	0	0	0	0	0	0	0	
Surr: 4-Bromofluorobenzene	0.9552	0	1	0	95.5	64.6	131	0	0	0	
Surr: Dibromofluoromethane	0.9946	0	1	0	99.5	70.6	128	0	0	0	
Surr: Toluene-d8	0.9736	0	1	0	97.4	70.5	116	0	0	0	

Sample ID: LCS-164411	Client ID:	Units: mg/L	Prep Date: 07/27/2012	Run No: 225879
SampleType: LCS	TestCode: VOLATILES, TCLP SW1311/8260B	BatchID: 164411	Analysis Date: 07/27/2012	Seq No: 4728554

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	0.9314	0.10	1	0	93.1	51.3	142	0	0	0	
1,2-Dichloroethane	1.086	0.10	1	0	109	65.3	132	0	0	0	
2-Butanone	1.852	0.20	2	0	92.6	46.4	147	0	0	0	
Benzene	0.9868	0.10	1	0	98.7	70.2	125	0	0	0	
Carbon tetrachloride	0.8712	0.10	1	0	87.1	53.1	148	0	0	0	
Chlorobenzene	0.9860	0.10	1	0	98.6	73.5	121	0	0	0	
Chloroform	0.9268	0.10	1	0	92.7	66.6	121	0	0	0	
Tetrachloroethene	1.038	0.10	1	0.01740	102	65.3	137	0	0	0	
Trichloroethene	0.9530	0.10	1	0	95.3	63.6	129	0	0	0	
Vinyl chloride	0.8872	0.040	1	0	88.7	47.6	145	0	0	0	

Qualifiers:

»	Greater than Result value	«	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164411

Sample ID: LCS-164411	Client ID:		Units: mg/L	Prep Date: 07/27/2012	Run No: 225879
SampleType: LCS	TestCode: VOLATILES, TCLP SW1311/8260B		BatchID: 164411	Analysis Date: 07/27/2012	Seq No: 4728554

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Surr: 4-Bromofluorobenzene	1.041	0	1	0	104	64.6	131	0	0	0	
Surr: Dibromofluoromethane	1.024	0	1	0	102	70.6	128	0	0	0	
Surr: Toluene-d8	1.032	0	1	0	103	70.5	116	0	0	0	

Sample ID: 1207F25-001AMS	Client ID:		Units: mg/L	Prep Date: 07/27/2012	Run No: 225879
SampleType: MS	TestCode: VOLATILES, TCLP SW1311/8260B		BatchID: 164411	Analysis Date: 07/27/2012	Seq No: 4728851

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	1.145	0.10	1	0	114	46.9	155	0	0	0	
1,2-Dichloroethane	1.143	0.10	1	0	114	57.1	136	0	0	0	
2-Butanone	1.784	0.20	2	0	89.2	36.2	167	0	0	0	
Benzene	1.142	0.10	1	0	114	65.5	134	0	0	0	
Carbon tetrachloride	1.042	0.10	1	0	104	51.3	151	0	0	0	
Chlorobenzene	1.160	0.10	1	0	116	73	124	0	0	0	
Chloroform	1.062	0.10	1	0	106	61.3	128	0	0	0	
Tetrachloroethene	1.196	0.10	1	0	120	62.3	146	0	0	0	
Trichloroethene	1.128	0.10	1	0	113	66.2	140	0	0	0	
Vinyl chloride	1.096	0.040	1	0	110	35.3	161	0	0	0	
Surr: 4-Bromofluorobenzene	1.039	0	1	0	104	64.6	131	0	0	0	
Surr: Dibromofluoromethane	1.023	0	1	0	102	70.6	128	0	0	0	
Surr: Toluene-d8	1.033	0	1	0	103	70.5	116	0	0	0	

Sample ID: 1207F25-001ADUP	Client ID:		Units: mg/L	Prep Date: 07/27/2012	Run No: 225879
SampleType: DUP	TestCode: VOLATILES, TCLP SW1311/8260B		BatchID: 164411	Analysis Date: 07/27/2012	Seq No: 4728848

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
1,1-Dichloroethene	BRL	0.10	0	0	0	0	0	0	0	30	
1,2-Dichloroethane	BRL	0.10	0	0	0	0	0	0	0	30	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H10

ANALYTICAL QC SUMMARY REPORT

BatchID: 164411

Sample ID: 1207F25-001ADUP Client ID: Units: mg/L Prep Date: 07/27/2012 Run No: 225879
SampleType: DUP TestCode: VOLATILES, TCLP SW1311/8260B BatchID: 164411 Analysis Date: 07/27/2012 Seq No: 4728848

Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
2-Butanone	BRL	0.20	0	0	0	0	0	0	0	30	
Benzene	BRL	0.10	0	0	0	0	0	0	0	30	
Carbon tetrachloride	BRL	0.10	0	0	0	0	0	0	0	30	
Chlorobenzene	BRL	0.10	0	0	0	0	0	0	0	30	
Chloroform	BRL	0.10	0	0	0	0	0	0	0	30	
Tetrachloroethene	BRL	0.10	0	0	0	0	0	0	0	30	
Trichloroethene	BRL	0.10	0	0	0	0	0	0	0	30	
Vinyl chloride	BRL	0.040	0	0	0	0	0	0	0	30	
Surr: 4-Bromofluorobenzene	0.9596	0	1	0	96	64.6	131	0.9422	0	0	
Surr: Dibromofluoromethane	0.9684	0	1	0	96.8	70.6	128	0.9600	0	0	
Surr: Toluene-d8	0.9688	0	1	0	96.9	70.5	116	0.9644	0	0	

Qualifiers:
- `>` Greater than Result value
- `<` Less than Result value
- B Analyte detected in the associated method blank
- BRL Below reporting limit
- E Estimated (value above quantitation range)
- H Holding times for preparation or analysis exceeded
- J Estimated value detected below Reporting Limit
- N Analyte not NELAC certified
- R RPD outside limits due to matrix
- Rpt Lim Reporting Limit
- S Spike Recovery outside limits due to matrix

APPENDIX C – TEST PIT PHOTOGRAPHS

Liddell Drive Equalization Project Photographs: 2012.3532.01

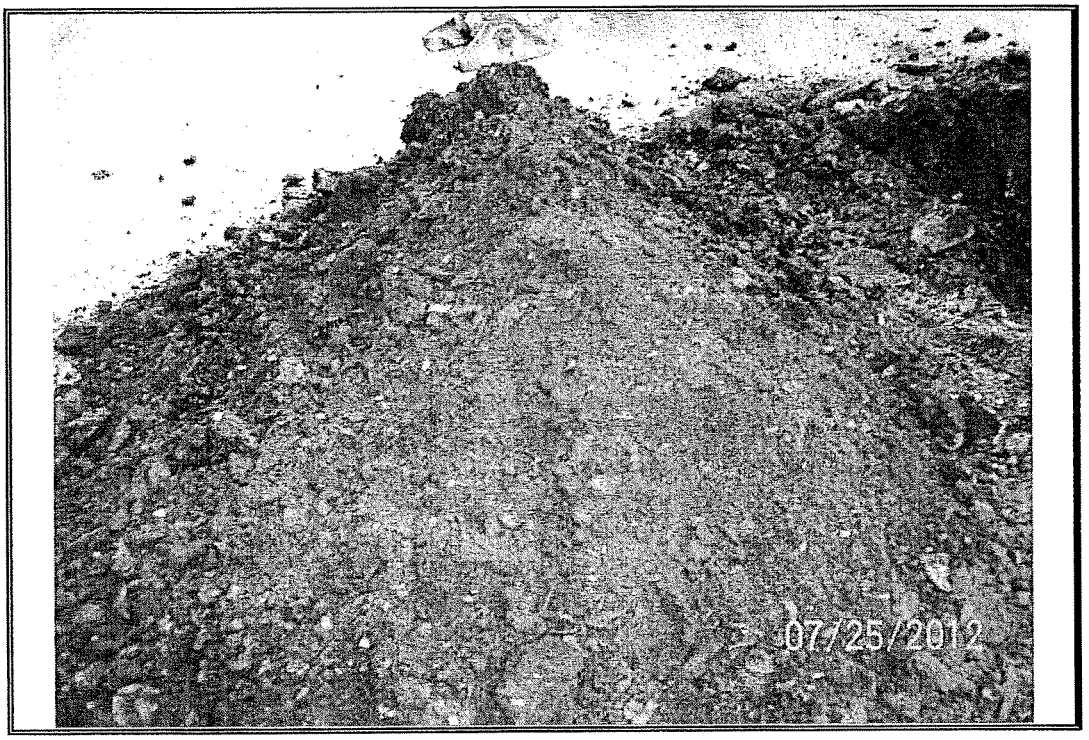


Photo # 1: Top 3 feet of soils excavated from TP-1.

Photo # 2: Remaining soils/debris excavated from TP-1.

Liddell Drive Equalization Project Photographs: 2012.3532.01

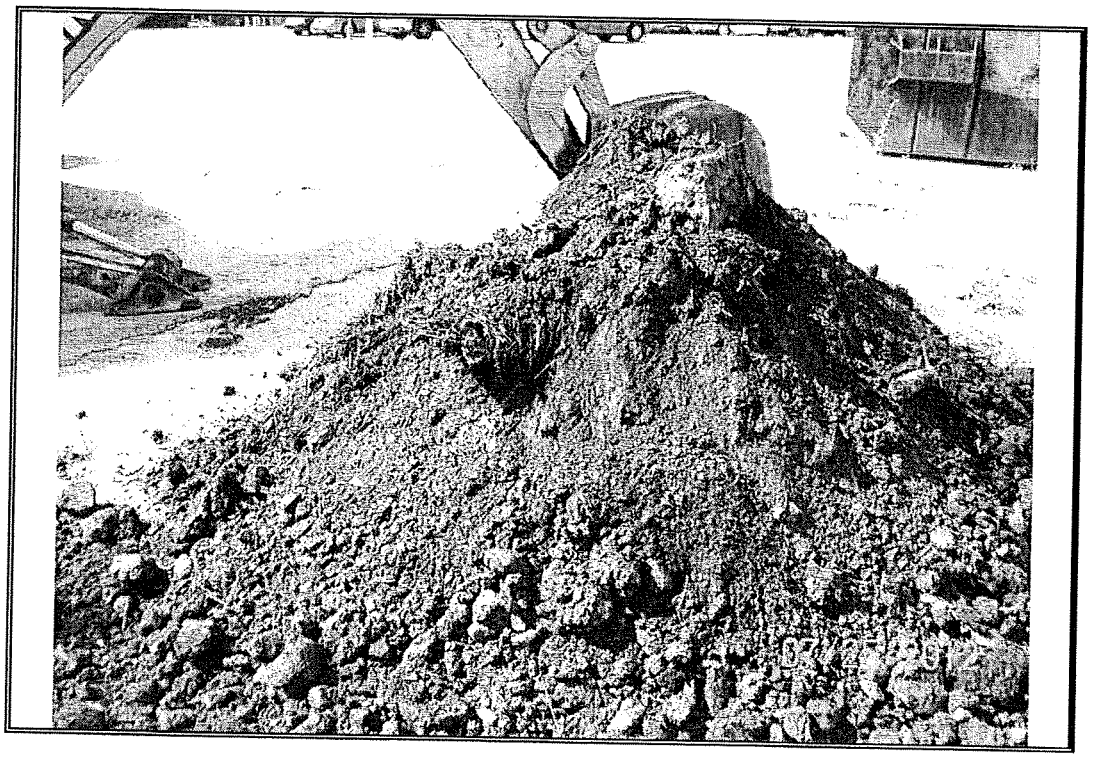


Photo # 3: View of stockpiled soils/debris excavated from TP-2.

Photo # 4: .View of soils excavated from TP-3.

Liddell Drive Equalization Project Photographs: 2012.3532.01

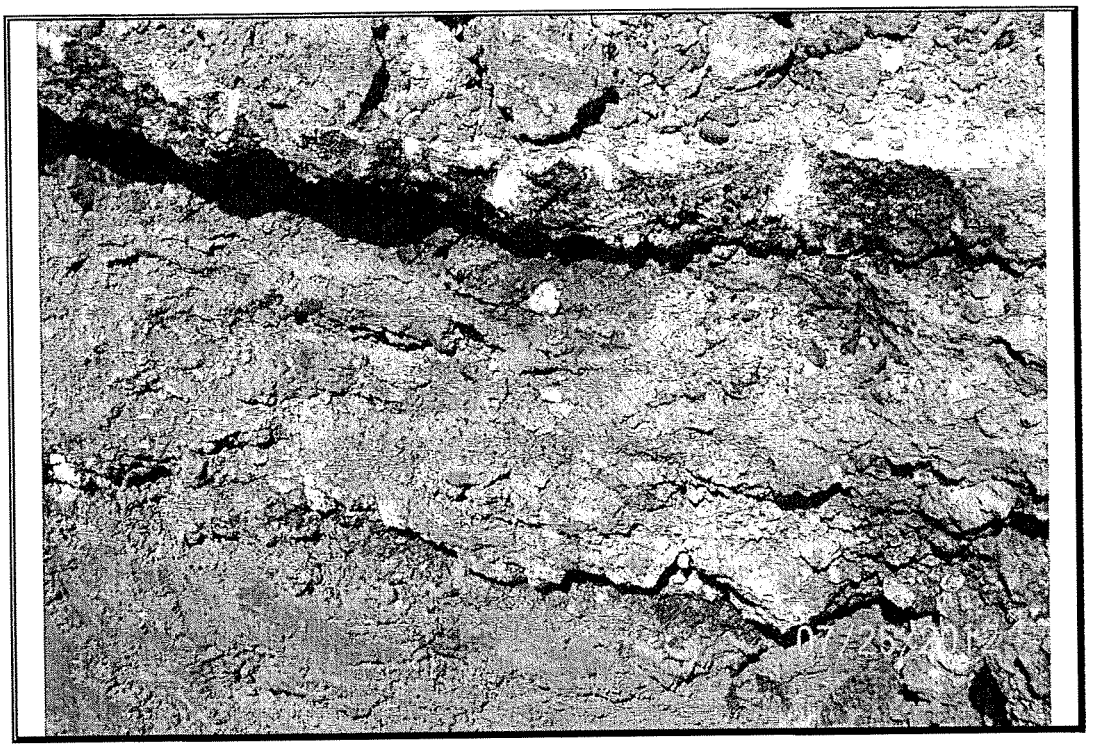


Photo # 5: View of 2 feet of "slag like" material just below the asphalt within TP-4.

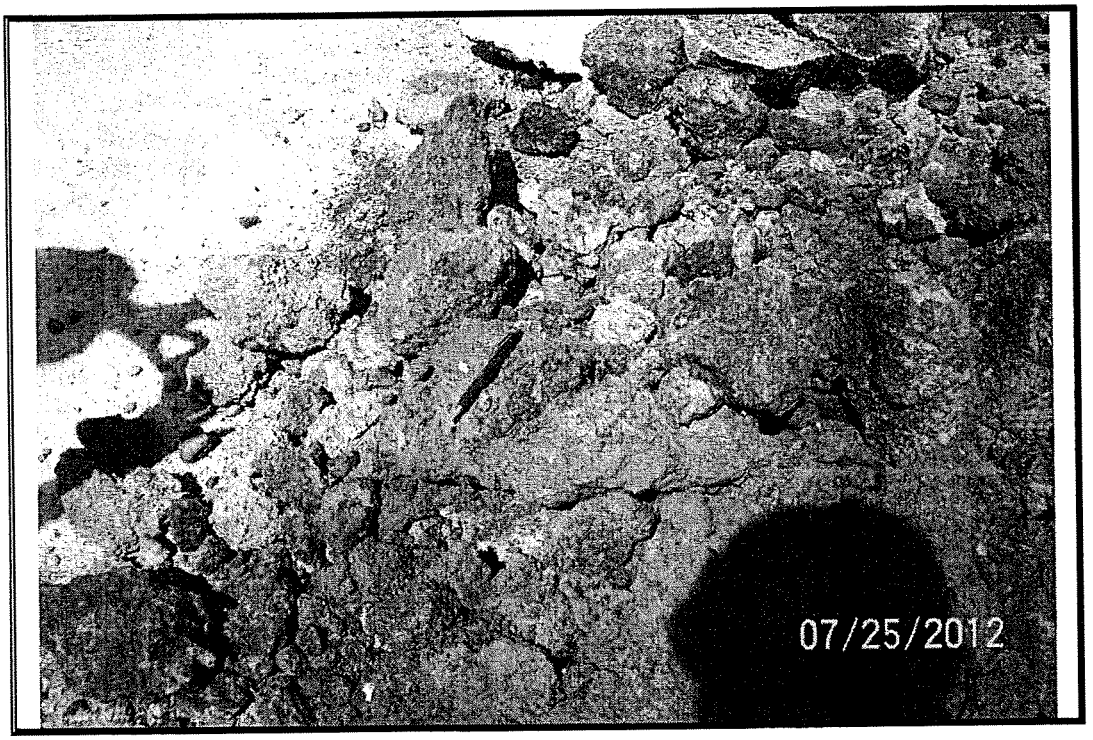


Photo # 6: View of "slag like" materials removed from TP-4.

Liddell Drive Equalization Project Photographs: 2012.3532.01

Photo # 7: View of top 2' of soils removed from test pit T-5.

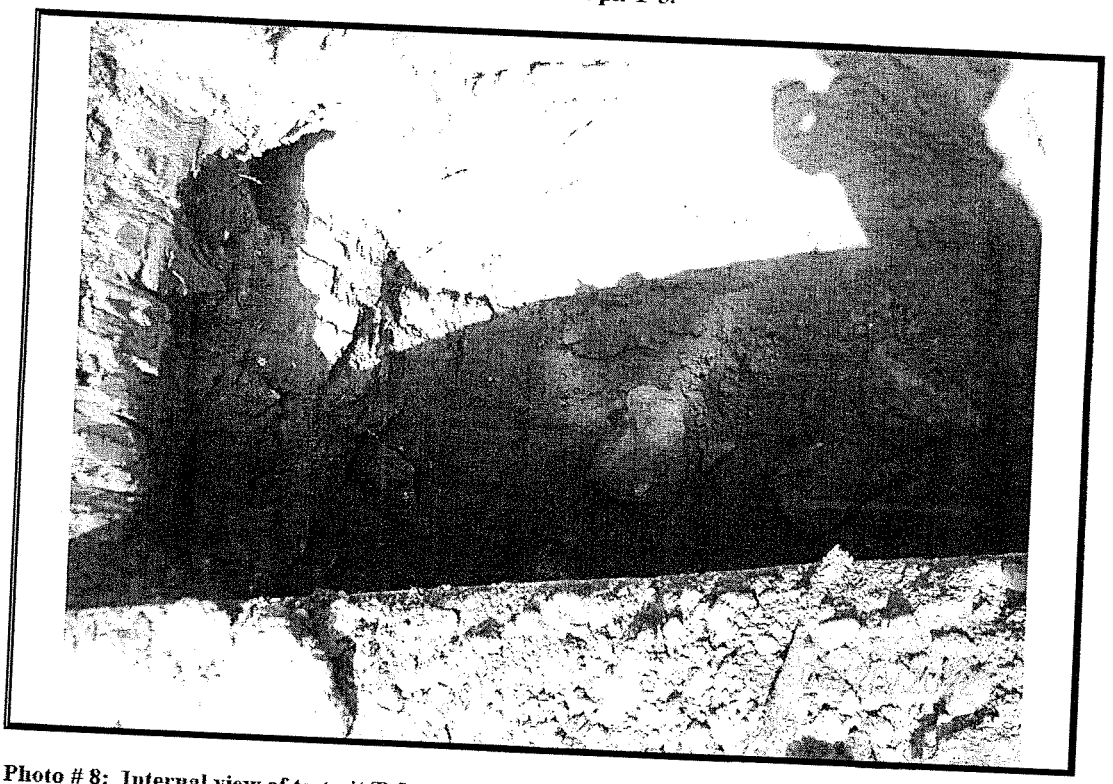


Photo # 8: Internal view of test pit T-5.

Liddell Drive Equalization Project Photographs: 2012.3532.01

Photo # 9: View of "slag like" material just below the asphalt surface at TP-6.

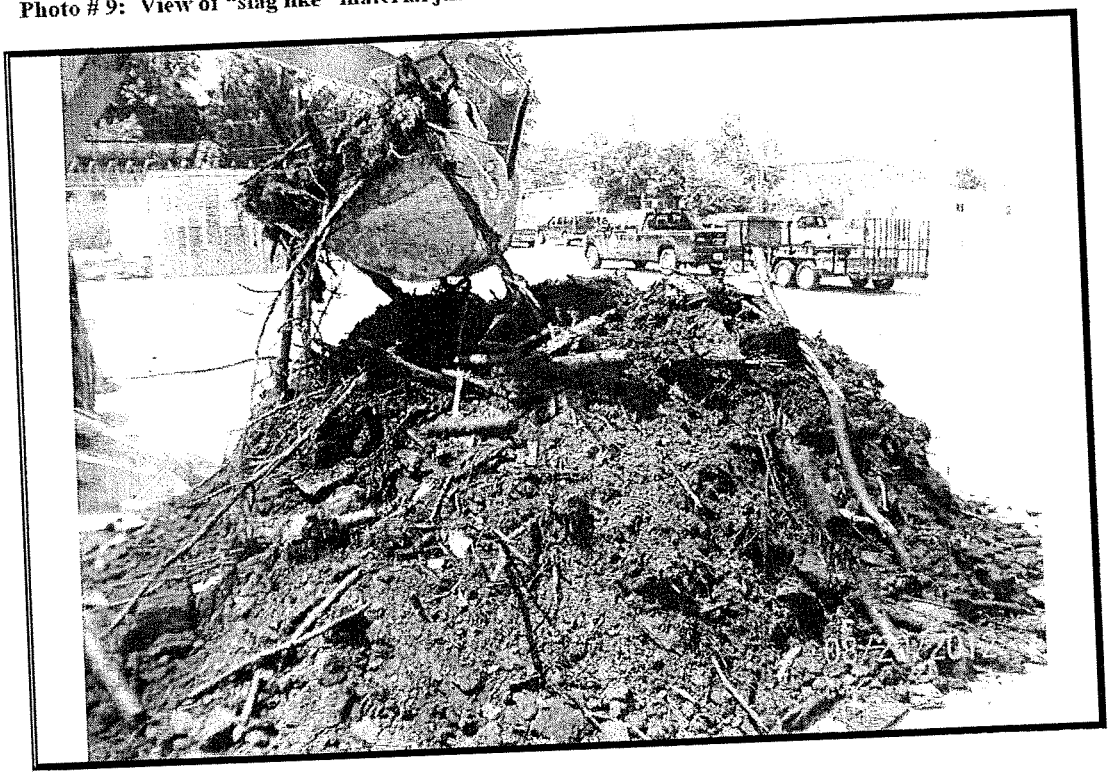


Photo # 10: View of debris removed from test pit TP-7.

Liddell Drive Equalization Project Photographs: 2012.3532.01

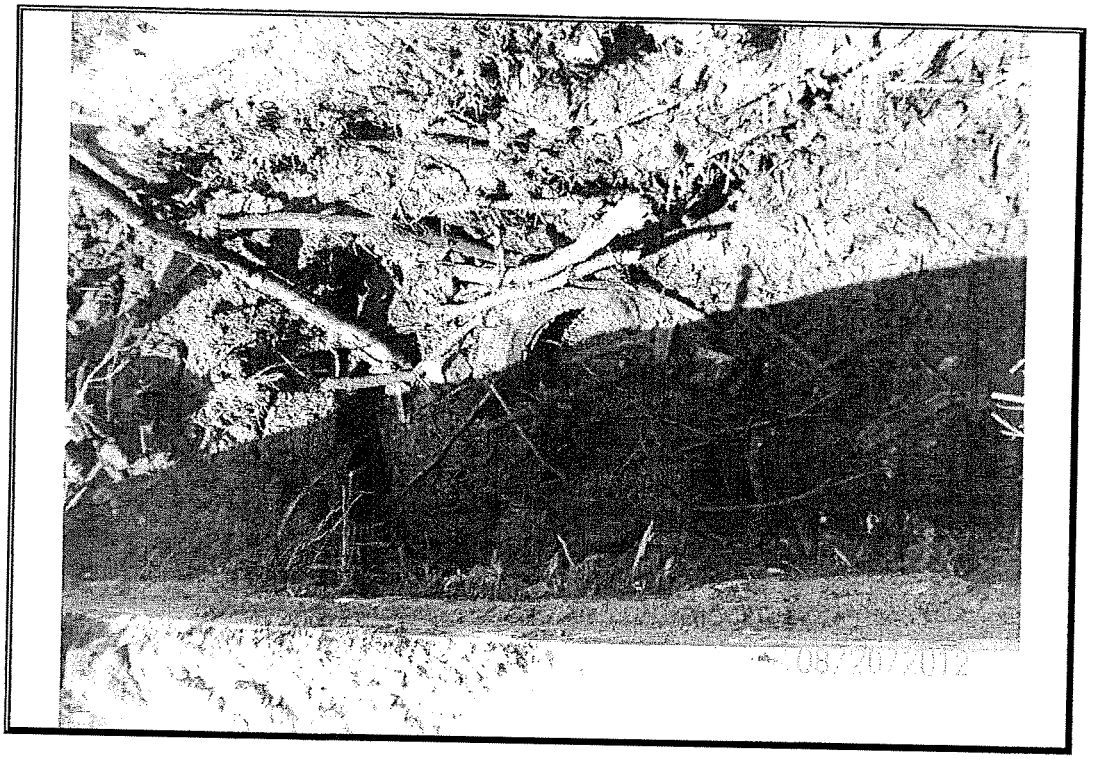
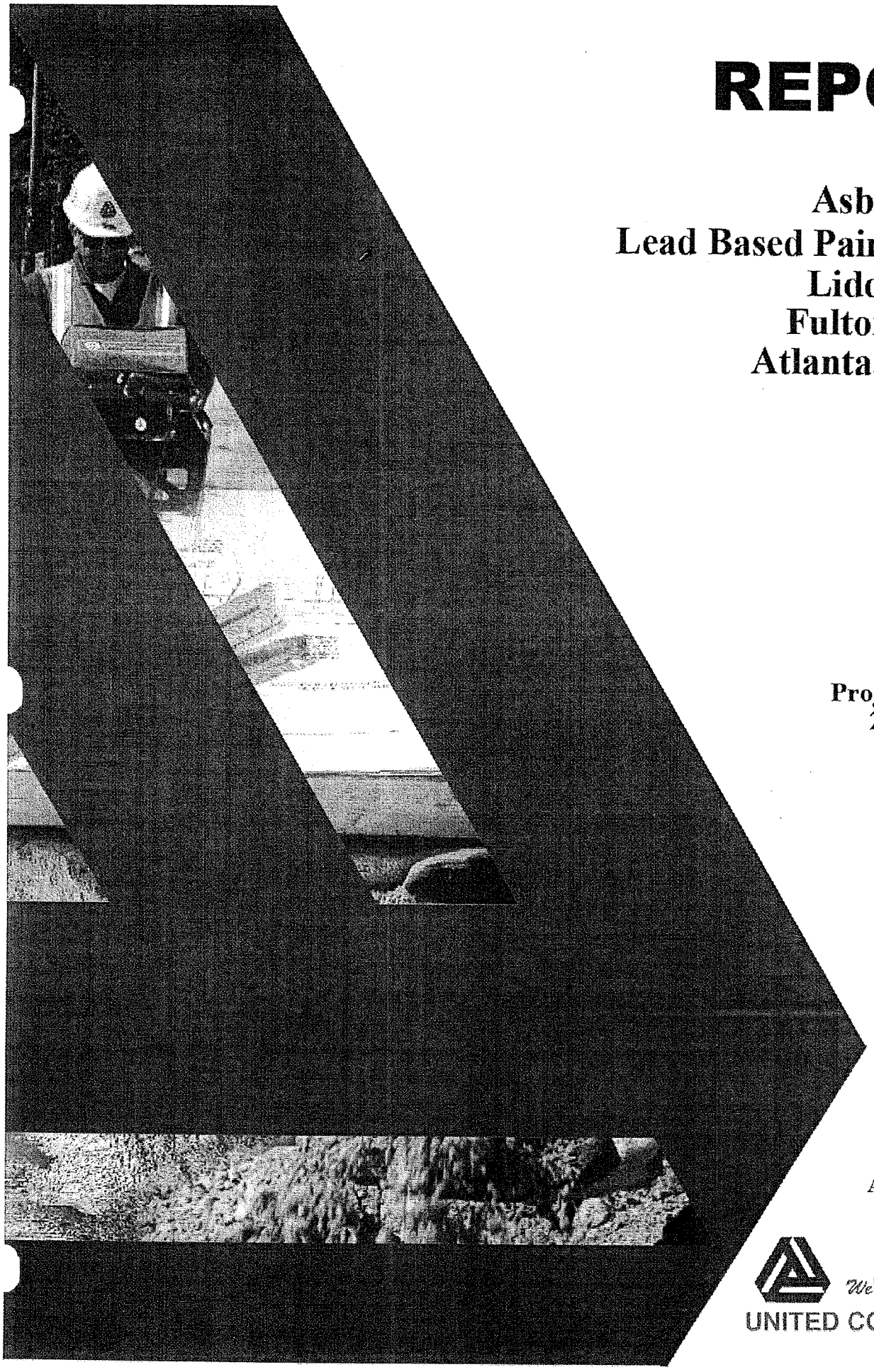


Photo # 11: Internal view of test pit T-7.

Photo # 12: Internal view of test pit T-8.



REPORT

Asbestos and Lead Based Paint Survey Liddell Drive Fulton County Atlanta, Georgia

Project Number
2012.3532.01

Report Date:
August 2, 2012
Survey Date:
July 25, 2012

We're here for you
UNITED CONSULTING

We're here for you
UNITED CONSULTING

August 2, 2012

Mr. Stephen Lathrop, P.E.
Atlanta Services Group-Jacobs
6801 Governors Lake Parkway
Norcross, GA 30071

Via e-mail: ***Stephen.Lathrop@jacobs.com***

RE: Report of Asbestos and Lead Based Paint Survey
Liddell Drive Equalization Project
Atlanta, Georgia
Project No. 2012.3532.01

Dear Mr. Lathrop:

United Consulting has completed the Asbestos and Lead Based Paint Survey on the above referenced Project Site. These activities were performed by an accredited asbestos inspector in substantial conformance with industry standards. It was our pleasure to assist you with this project and look forward to assisting you with future projects. Please contact us if you have any questions or if we can be of further assistance.

Sincerely,

UNITED CONSULTING

Ian Pilling
Senior Environmental Specialist

Scott D. Smelter
Principal

RCG/BB/IGP/SDS/tl

SharePoint:2012.3532.01

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FIGURES

APPENDICES

EXECUTIVE SUMMARY[1]

United Consulting has completed the Asbestos and Lead Based Paint Survey on the two vacant structures located along Liddell Drive in the area of the Liddell Drive Equalization Project in Atlanta, Fulton County, Georgia (hereinafter referred to in this report as the Project Site). One structure was an apparent former maintenance garage of cinder block construction, and the second was a smaller building of steel frame with sheet metal construction. The results are briefly summarized below. The text of the report should be reviewed for a discussion of the following items:

I. Limited Lead Based Paint Survey

1. United Consulting performed a lead-based paint survey of the Project Site building to visually identify suspect lead-based paint films on interior and exterior building components. Six representative paint chip samples were collected from one structure and submitted for laboratory testing. Painted surfaces were not observed on the second structure.

2. The painted surfaces identified at the Project Site were in poor condition at the time of United Consulting's survey activities. Three of the six samples were found to contain lead-based paint above the current Department of Housing and Urban Development (HUD) action level of 0.5% lead by weight.

3. Occupational Safety and Health Administration (OSHA) regulations require that workers be protected from exposure to lead via proper engineering controls and appropriate levels of personal protective equipment. Additionally, lead-based painted waste materials must be tested for hazardous characteristics using the Toxicity Characteristic Leaching Procedure (TCLP method), prior to disposal. Solid waste which leaches hazardous concentrations of lead greater than 5.0 parts per million (ppm) by TCLP, must be properly disposed of in an appropriate permitted landfill.

II. Asbestos Survey

1. Bulk samples of typical suspect asbestos-containing materials such as caulk, mastics, and roofing materials, were collected and submitted to a laboratory for testing using Polarized Light Microscopy (PLM).

1 This Executive Summary is not intended to be used or relied upon without reference to the entire report and cannot otherwise be properly understood and interpreted. It is provided solely for the convenience of the Client and not as a substitute for the report or review of the report.

2. Regulated concentrations of asbestos **were identified** in twelve of the twenty five bulk samples collected from the Project Site. The regulated asbestos containing materials identified at the Project Site generally included: interior/exterior window glazing, expansion joint caulk, roof decking, and vent pipe tar/roof penetration mastic. The remaining samples submitted for analytical testing were not found to contain regulated concentrations of asbestos.

3. The National Emissions Standard for Hazardous Air Pollutants (NESHAP) requires the removal of asbestos-containing materials prior to activities, which would disturb them. United Consulting recommends that the asbestos-containing materials be removed prior to demolition, by a qualified asbestos abatement contractor using State of Georgia accredited personnel, in accordance with applicable federal, state and local regulations governing the removal of asbestos-containing material.

4. A Ten-Day Notification must be forwarded to the Georgia Department of Natural Resources - Environmental Protection Division, by the building owner or demolition/renovation contractor, prior to the start of any building demolition/renovation activities.

INTRODUCTION

United Consulting was retained by **Atlanta Services Group** to perform a Lead Based Paint (LBP) and Asbestos Survey on the Project Site. The scope of this assessment was outlined in our July 20, 2012 proposal, which was authorized via a Task Order (No. 4906004-1) dated July 23, 2012. The purpose of this survey was to collect and test representative samples of common building materials for the presence of LBP and asbestos fibers that may be present in the structures. United Consulting understands that these structures are planned for demolishion. Photographs of the Project Site structures are included in Appendix A.

The asbestos bulk sample collection activities were performed by United Consulting representative, Mr. Britt Bickerstaff. He is an accredited Asbestos Inspector in accordance with the Asbestos Hazard Emergency Response Act (AHERA), Inspector Certificate Number 4338. The LBP sample collection activities were performed by United Consulting representative, Mr. Ian Pilling. He is a licensed lead based paint inspector with the State of Georgia, certification number 60 INSO 0712 3443. Their certifications and that of the laboratory used for this investigation are reproduced in Appendix B.

DESCRIPTION OF FACILITY

The Project Site contained two, single story buildings, used for storage and or maintenance (formerly). They are located to the southeast of the work area for the equalization tank associated with the Liddell Drive Equalization Project. The former maintenance garage structure is about 2,700 square feet and of cinder block construction with an attached overhang/canopy. The storage structure is about 1,300 square feet and consisted of a steel frame with sheet metal paneling siding and roof. Both structures were constructed on concrete slabs. An automobile service bay was located within the interior of the concrete block building. The construction date of these is unknown, but from appearance is likely pre-1970. The roof of the cinder block building consisted of gravel followed by typical roofing materials (tar, shingles, perlite, and decking). There were glass windows on each building. No drywall systems materials or flooring materials were observed in either structure. The locations of the buildings included in this assessment are illustrated on Figure 1.

I. LEAD BASED PAINT SURVEY

PURPOSE

The purpose of the Lead-Based Paint Survey was to visually identify suspect lead-based paint films on the interior and exterior building components, and to test the paint films for detectable concentrations of lead by collecting representative paint chip samples from the Project Site. United Consulting performed the survey in substantial conformance to industry standards.

SCOPE

The lead-based paint survey involved the following protocol:

1. Visually examined accessible interior and exterior building components to identify suspect lead-based paint films;

2. Described each suspect lead-based paint film and noted the components or surfaces to which the paint films were applied;

3. Assessed the condition of the suspect lead-based paint films and noted the condition of the painted surface;

4. Collected six paint chip samples of suspect lead-based paint films from a representative sample of the interior and exterior building components and submitted these samples for analysis utilizing Atomic Absorption Spectrometry (AAS).

SAMPLE ANALYSIS

Procedure

Six (6) paint chip samples were obtained by either chipping or coring the film and substrate materials. Each sample was removed using a clean knife or core, and placed in a new dedicated container. Each container was separately labeled and taken to the laboratory for analytical testing. Each sample was assigned a unique sample number and delivered to an independent laboratory (Analytical Environmental Services, Inc.) for analysis. Chain of Custody was documented and retained on-file. The laboratory results are attached in Appendix C.

SURVEY RESULTS

Overview

Three of the six samples collected were found to contain lead concentrations above the current HUD action level of 0.5% lead by weight. Table 1 lists the sample descriptions and laboratory results. Photocopies of the laboratory results are included in Appendix C.

TABLE 1: LEAD BASED PAINT SAMPLE RESULTS

SAMPLE NUMBER	CONDITION	LOCATION	COLOR	PERCENT LEAD BY WEIGHT
L-1	Poor	C Bld, floor around pit	Yellow	1.36
L-2	Poor	C Bld, Door	Red	0.110
L-3	Poor	C Bld, exterior walls	White	1.3
L-4	Poor	C Bld, Interior walls	White	0.18
L-5	Poor	C Bld, Support columns for overhang	Reddish	0.0753
L-6	Poor	C Bld, Bumper protectors, Side of the garage bays entrance	Red	15.4

Notes:
Results presented in percentage of lead by weight.
C Bld = Concrete Block Building

ASSESSMENT/RECOMMENDATIONS

A total of six paint chip samples were collected and submitted for laboratory analysis. Three of the samples **were found** to contain lead at concentrations above the current HUD action level of 0.5% lead by weight. Three samples were found to contain lead below the HUD action level. The samples with lead above the HUD action level were from the concrete block building. Painted materials were not observed on the second building with the exception of the factor painted doors which based on appearance were manufactured after 1978 and, therefore, were not tested.

Occupational Safety and Health Administration (OSHA) regulations require that workers be protected from exposure to lead via proper engineering controls and appropriate levels of personal protective equipment as per Title 29 of the Code of Federal Regulations, part 1926.62 (29 CFR 1926.62).

Solid waste which leaches hazardous concentrations of lead greater than 5.0 parts per million (ppm) by TCLP must be properly disposed of in an appropriately permitted hazardous waste landfill.

II. ASBESTOS SURVEY

SCOPE

In performing the assessment, United Consulting's representative:

1. Visually examined the accessible areas of the building to identify suspect asbestos-containing materials which could be impacted by the planned demolition activities;

2. Physically examined suspect materials to evaluate whether the materials were friable or non-friable (a friable material is any material that, when dry, may be crumbled, pulverized or reduced to a powder using hand pressure);

3. Described the suspect material and noted the area where the material was located;

4. Assessed the condition of the suspect materials to be sampled as well as their potential for impact during the planned renovation/demolition;

5. Collected 25 bulk samples of suspect materials for testing;

6. Tested bulk samples obtained for detectable concentrations of asbestos using PLM and dispersion oil staining;

7. Prepared this report to document the sampling activities and results of the tests performed.

BULK SAMPLE COLLECTION

Overview

Bulk sampling was performed in substantial conformance with the United States Environmental Protection Agency's (EPA's), "Guidance for Controlling Asbestos-Containing Materials in Buildings" (EPA 560/5-85-024, 1985).

Sample Location Selection

Sample locations were randomly chosen in the field, based on the identification of suspect asbestos-containing material (SACM). A distributed sampling plan based on a randomized

sampling scheme was not used for this sampling program. This survey was being conducted to evaluate the property for the presence of asbestos prior to possible building demolition.

Bulk samples were collected from typical suspect materials such as caulk, roofing materials, and other suspect materials. Bulk samples were not collected of non-suspect materials such as carpets, drapes, wood or ceramic tiles.

Procedure

Samples were collected by wetting the material to be sampled, by extracting a representative section of the suspect material and by placing the material in a sample container. Each sample was assigned a unique sample number and delivered to an independent laboratory (Analytical Environmental Services, Inc.) for analysis. Chain of Custody was documented and retained on-file.

BULK SAMPLE ANALYSIS

Procedure

The bulk samples were tested for detectable concentrations of asbestos (greater than one percent asbestos) utilizing Polarized PLM and dispersion staining techniques. The testing method used was the "Interim Method for the Determination of Asbestos in Bulk Insulation Samples" (EPA 600/M4-82020, as amended). Bulk sample testing was performed by Analytical Environmental Services, Inc., a successful participant in the National Voluntary Laboratory Accreditation Program (NVLAP), certificate number 102082-0.

Asbestos identification was achieved by examining the morphology and optical properties of the sampled material. Optical properties include the color under dispersion staining, birefringence, extinction characteristics, and Sign of Elongation. Quantification was obtained by visual estimation. The PLM method may be used for the analysis of samples containing from 0 to 100 percent asbestos. The lower limit of detection is less than 1 percent and the upper detection limit is 100 percent. Results are reported as percent of asbestos by type (e.g. Amosite, Chrysotile, Crocidolite, etc.). Additional information such as other fibrous and non-fibrous components is also reported if noted in the sample.

BULK SAMPLE RESULTS

Overview

United Consulting collected 25 bulk samples of suspect asbestos-containing materials from the Project Site building. The assessment of results discussed below has been compiled by homogenous area and material type (e.g., caulk, roofing materials, etc.). Photocopies of the

laboratory results are included in Appendix C, and a complete list of all the bulk samples collected is provided in Table 2. The materials identified as containing asbestos are described below.

Asbestos Containing Materials

Materials identified at the Project Site as containing regulated concentrations of asbestos fibers include:

1. Interior/exterior window glazing and
2. Expansion joint caulk
3. Roof decking
4. Vent pipe tar/roof penetration mastic

TABLE 2: ASBESTOS BULK SAMPLES

SAMPLE NUMBER	CONDITION FRIABILITY	LOCATION	MATERIAL	RESULTS
A-1	Poor/Non-Friable	M Bld (int)	Insulation	ND
A-2	Poor/ Non-Friable	M Bld (int)	Insulation Paper	ND
A-3	Poor/ Non-Friable	M Bld (int)	Insulation	ND
A-4	Poor/ Non-Friable	M Bld (int)	Insulation Paper	ND
A-5	Fair / Non-Friable	M Bld (ext)	Window Caulk	ND
A-6	Fair / Friable	M Bld (ext)	Window Caulk	ND
A-7	**Poor / Friable**	**M Bld (ext)**	**Window Glazing**	**2% CH**
A-8	**Poor / Friable**	**M Bld (ext)**	**Window Glazing**	**2% CH**
A-9	**Fair / Non-Friable**	**M Bld (ext)**	**Roof Penetration Mastic**	**15% CH**
A-10	Fair / Non-Friable	C Bld (ext)	Roof Tar	ND
A-11	Fair / Non-Friable	C Bld (ext)	Roof- Layer 1-Tar	ND
A-12	Fair / Non-Friable	C Bld (ext)	Roof- Layer 2-Shingle	ND
A-13	Fair / Non-Friable	C Bld (ext)	Roof- Layer 3-Perlite	ND
A-14	**Fair / Non-Friable**	**C Bld (ext)**	**Roof-Vent Pipe Tar/Mastic**	**20% CH**
A-15	**Fair / Non-Friable**	**C Bld (ext)**	**Roof-Vent Pipe Tar/Mastic**	**20% CH**
A-16	Fair / Non-Friable	C Bld (ext)	Roof Rolling/Felt Paer w/ Tar	ND
A-17	Fair / Non-Friable	C Bld (ext)	Roof Felt Paper-Layer 2	ND
A-18	Fair / Non-Friable	C Bld (ext)	Roof Felt Paper-Layer 3	ND

SAMPLE NUMBER	CONDITION FRIABILITY	LOCATION	MATERIAL	RESULTS
A-19	**Fair / Non-Friable**	**C Bld (ext)**	**Roof Decking**	**20% CH**
A-20	**Poor/Friable**	**C Bld (int)**	**Window Glazing**	**2% CH**
A-21	**Poor/Friable**	**C Bld (int)**	**Window Glazing**	**2% CH**
A-22	**Fair / Non-Friable**	**C Bld (int)**	**Roof Decking**	**20% CH**
A-23	**Fair / Non-Friable**	**C Bld (ext)**	**Expansion Joint Caulk**	**15% CH**
A-24	Poor /Friable	**C Bld (ext)**	**Window Glazing**	**2% CH**
A-25	Poor/Friable	**C Bld (ext)**	**Window Glazing**	**2% CH**

Bold = regulated asbestos containing materials
ND= Non-detect; CH=chrysotile
M Bld =Metal Building
C Bld = Concrete Block Building
(ext)= exterior, (int)= interior

DATA EVALUATION/ASSESSMENT

Regulated concentrations of asbestos **were identified** in twelve of the bulk samples collected from the Project Site. The regulated asbestos containing materials identified at the Project Site included: window glazing from both buildings (interior and exterior), roof penetration mastic/tar from the roofs of both buildings, roof decking and expansion joint caulk from the concrete block/maintenance building. The remaining samples submitted for analytical testing were not found to contain regulated concentrations of asbestos. The entire roof/ceiling (interior and exterior areas) of the concrete block building was comprised of the roof decking material. Both structures were observed to contain window glazing. The expansion joint caulk on the concrete block building was located in the exterior joint between the roof and concrete blocks, and appeared to be present around the entire circumference of the building.

In the event that inaccessible, suspect ACM are encountered within previously inaccessible building areas (wall cavities, columns, etc.) at the time of demolition, United Consulting should be contacted and proper samples of the suspect materials should be collected and submitted for testing, prior to continuing demolition activities which could disturb these materials and potentially result in an asbestos fiber release.

The National Emissions Standard for Hazardous Air Pollutants (NESHAP) requires the removal of asbestos-containing materials prior to activities, which would disturb them. United Consulting recommends that the asbestos-containing materials be removed, prior to demolition by a qualified asbestos abatement contractor, using State of Georgia accredited personnel, in accordance with applicable federal, state and local regulations governing the removal of asbestos-containing material.

A properly prepared Ten Day Notification must be forwarded to the Georgia Department of Natural Resources - Environmental Protection Division, by the building owner or renovation contractor, prior to the start of any building demolition/renovation activities.

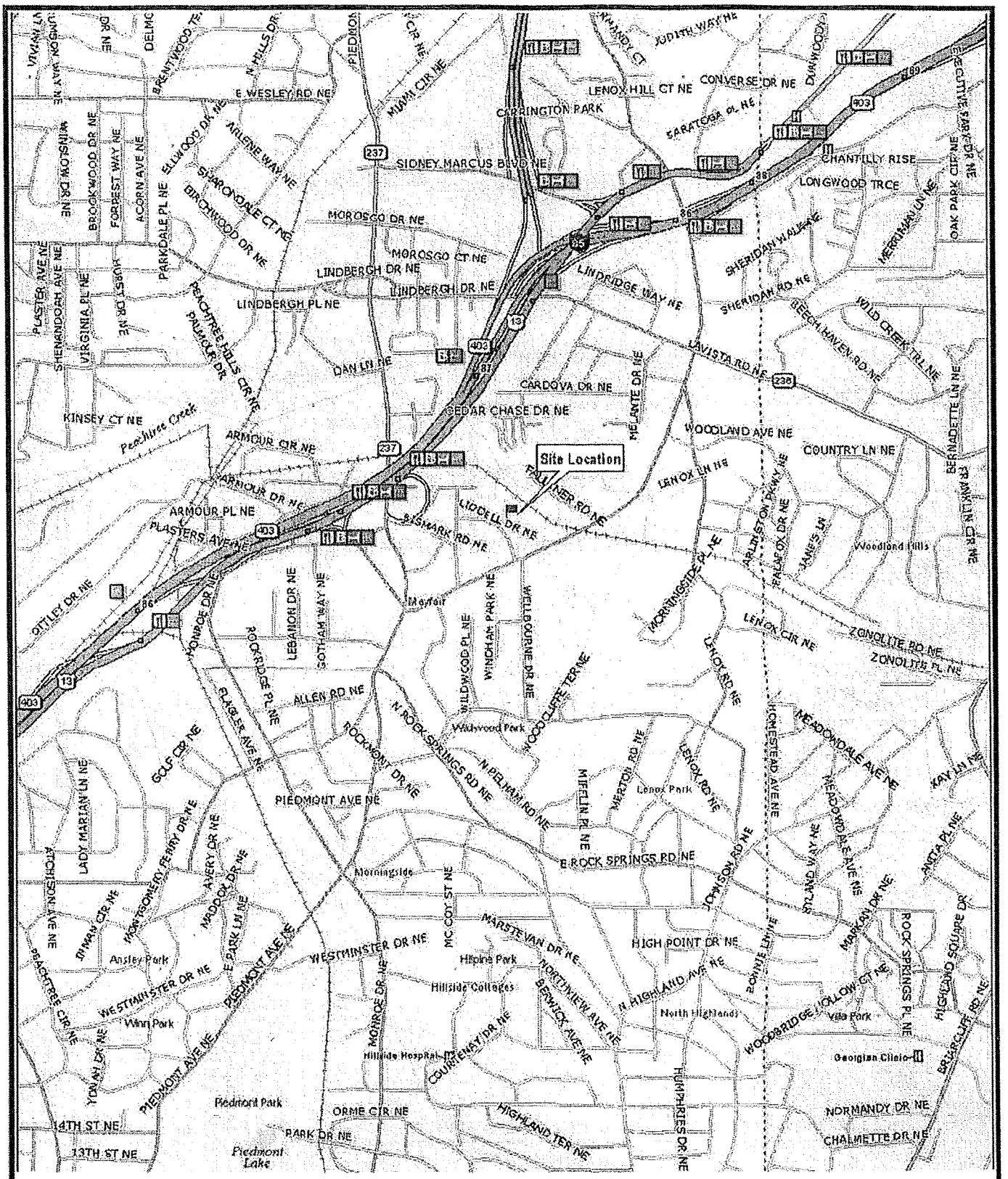
LIMITATIONS

The conclusions presented in this Asbestos Survey and Lead Based Paint Survey are based on the laboratory results and condition of the materials identified. Asbestos and lead paint concentrations will vary between sample locations, and in un-sampled locations. Our assessment of the lead-based paint at the Project Site is a professional opinion arrived at through the method and procedures accepted by, and standard to, the industry. No other warranty or guarantee is expressed or implied.

Representative areas of the Project Site were sampled. ***Preparation of abatement design bid documents or scopes of work for abatement, may require additional sampling and definition of the extent of the asbestos materials.*** United Consulting shall not be held responsible for errors, miscalculations, assumptions, misinterpretations or other problems or liabilities arising from, or associated with, firms or individuals bidding on asbestos abatement work that rely solely, or in part, on this document.

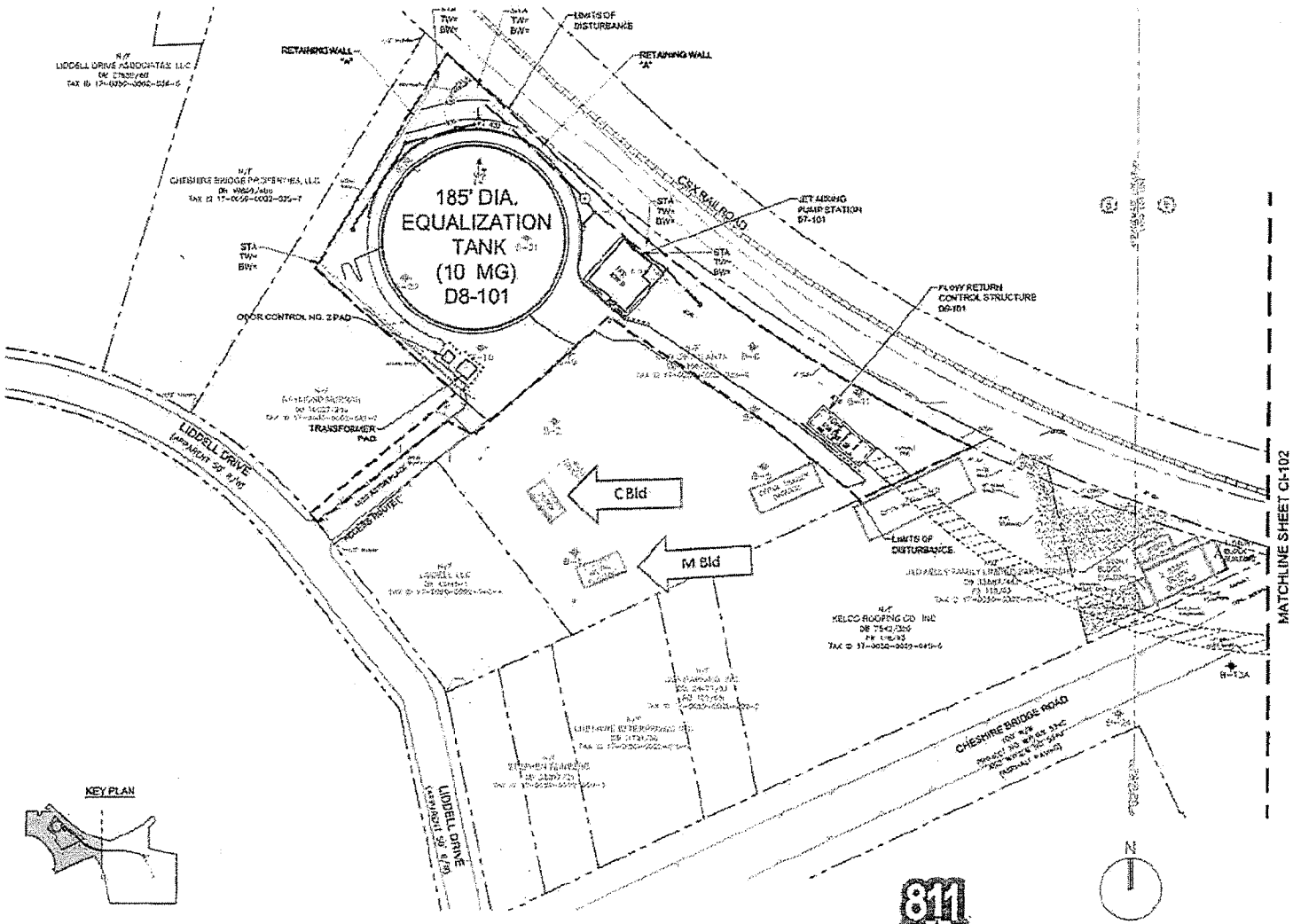
This report has been prepared on behalf of **Jacobs** in conjunction with the **City of Atlanta**. Should any other person, partnership, or corporation desire to rely upon this report, it will be necessary for United Consulting to update the report for the new user.

UNITED CONSULTING



We're here for you UNITED CONSULTING	N	Scale:	1"=2,000"	Client:	Jacobs
		Prepared:	BNB	Site:	Liddell Drive Equalization Project
		Checked:	RCG		
		Project No.:	2012.3532.01	Title:	Site Location Map

FIG. 1



We're here for you UNITED CONSULTING	N	Scale:	As Shown	Notes:	Client:	Jacobs
		Prepared:	BNB		Site:	Liddell Drive Equalization Project
		Checked:			Title:	Site Location Plan
		Project No.:	2012.3532.01			FIG. 1a

APPENDIX A – PHOTOGRAPHIC DOCUMENTATION

Liddell Drive Equalization Project Asbestos
and Lead Based Paint Survey Photographs: 2012.2532.01

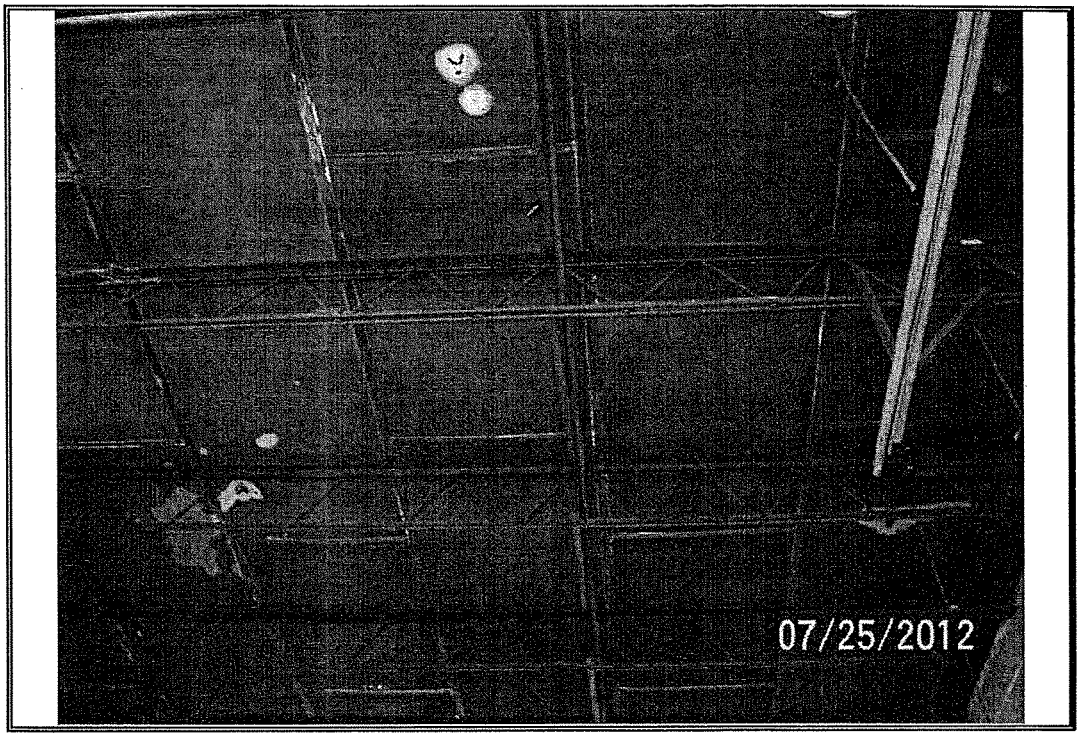


Photo # 1: View of interior roof decking in the C Bld. (20% CH)

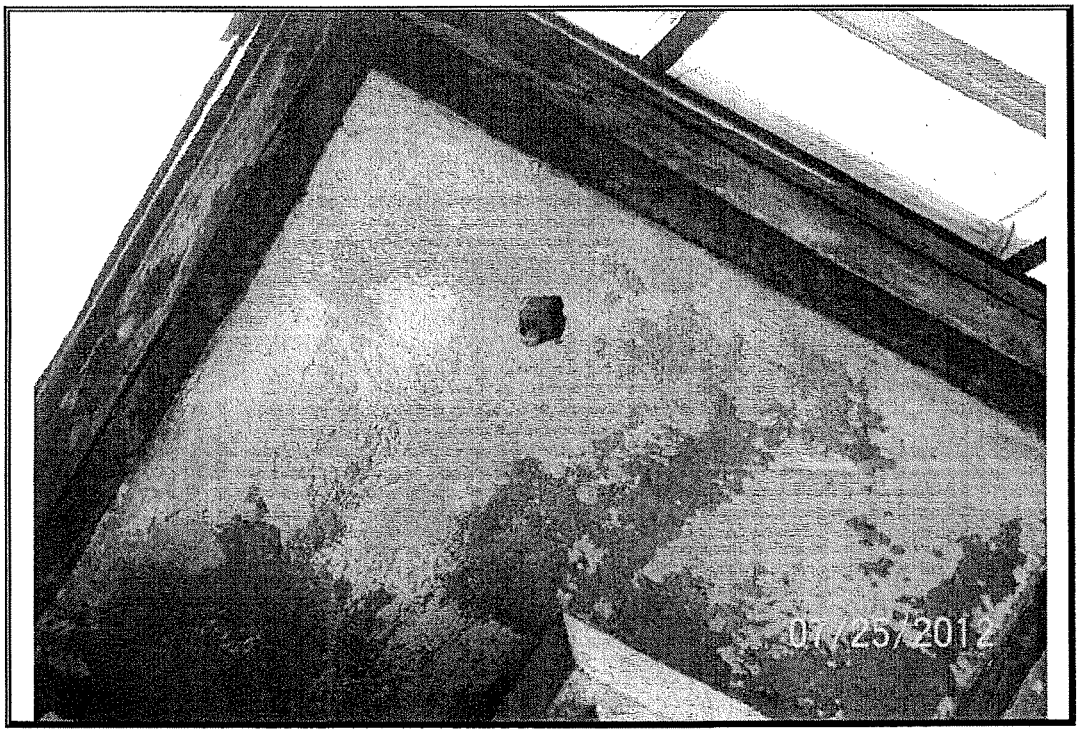


Photo # 2: View of exterior roof decking on C Bld. (20%CH)

Liddell Drive Equalization Project Asbestos and Lead Based Paint Survey Photographs: 2012.2532.01

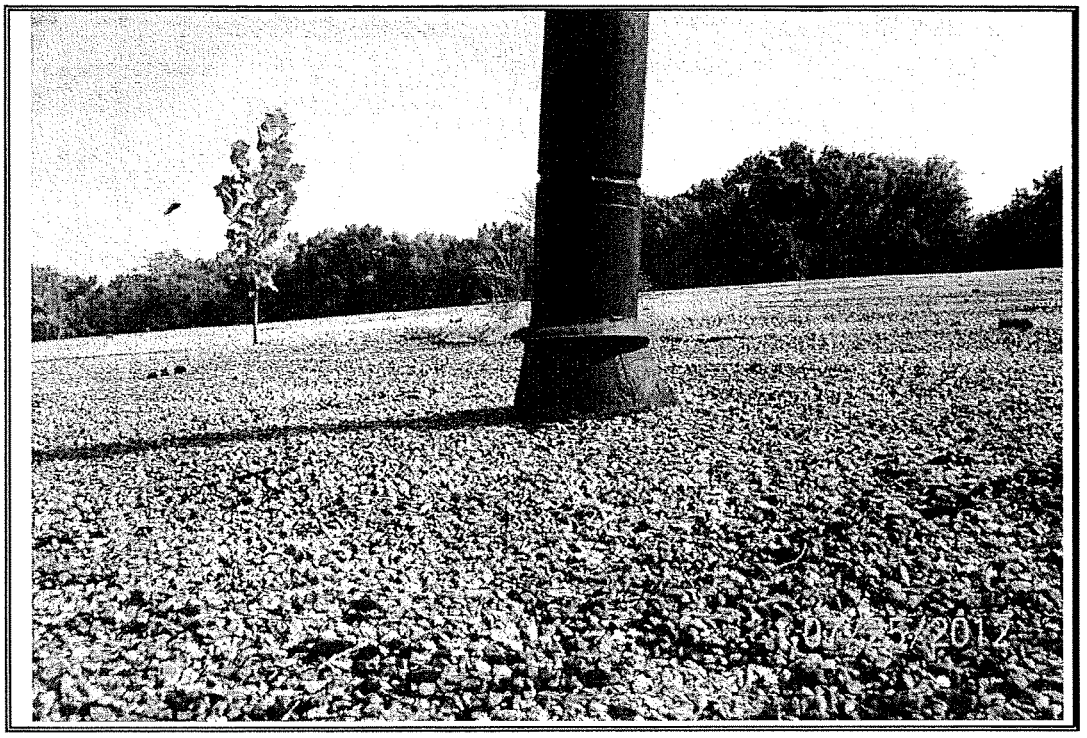


Photo # 3: .View of vent pipe/roof penetration mastic/tar on C Bld. (20 % CH)

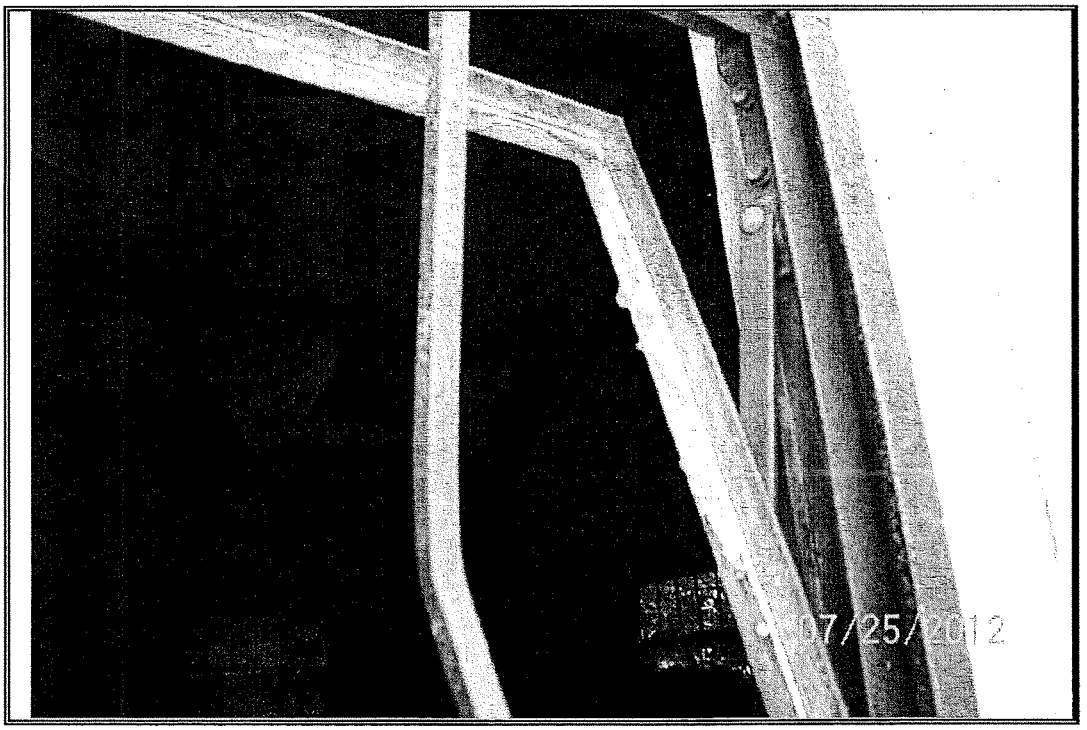


Photo # 4: View of window glazing on M Bldg window. (2% CH).

Liddell Drive Equalization Project Asbestos
and Lead Based Paint Survey Photographs: 2012.2532.01

Photo # 5: View of insulation in M Bld. (ND)

Photo # 6: View of the yellow paint identified as containing lead at 1.36 %.

Liddell Drive Equalization Project Asbestos
and Lead Based Paint Survey Photographs: 2012.2532.01

Photo # 7: View of the car bumper (red) and the exterior wall (white) both found to contain lead at 15.4 % and 1.3 %, respectively.

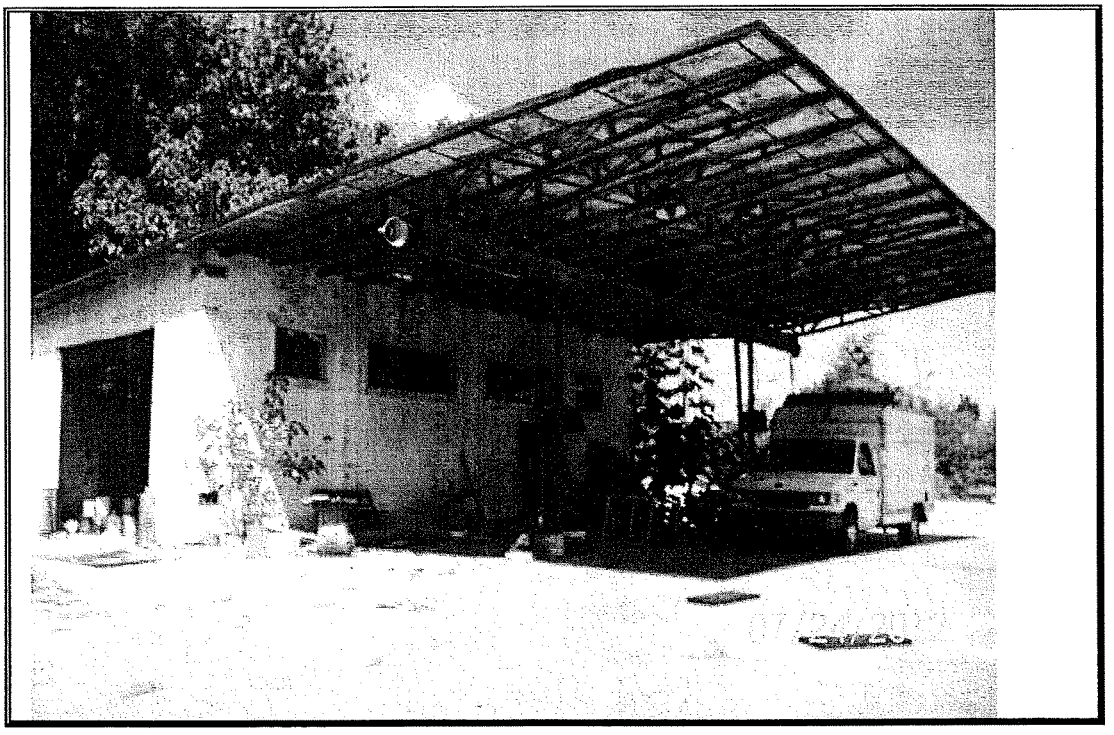


Photo # 8: View of the concrete block building.

APPENDIX B – CERTIFICATIONS

The Environmental Institute

Britt Bickerstaff

Social Security Number - XXX-XX-8663
United Consulting - 625 Holcomb Bridge Road - Norcross, Georgia 30071

Has completed coursework and satisfactorily passed an examination that meets all criteria required for EPA/AHERA/ASHARA (TSCA Title II) Approved Accreditation

Asbestos in Buildings: Inspection and Assessment

August 8-10, 2011
Course Date

August 10, 2011
Examination Date

August 9, 2012
Expiration Date

4338
Certificate Number

Thomas G. Laubenthal - Principal Instructor

Rachel G. McCain - Exam Administrator

David W. Hogue - Training Manager

(Approved by the ABIH Certification Maintenance Committee for 3 CM points)
(American Council for Accredited Certification - Re-certification Credit Registration #11021802)
(Florida Provider Registration Number 0001342 - Course #0004700)
TEI - 1841 West Oak Parkway, Suite F - Marietta, Georgia 30062 - (770) 427-3600 - www.tei-atl.com

Georgia Environmental Protection Division

Lead-Based Paint and Asbestos Program

Certification, Accreditation, Licensing Unit

Judson H. Turner, Director
4244 International Parkway, Suite 104
Atlanta, Georgia 30354

Certification To Conduct Georgia Regulated Lead-Based Paint Activities

Discipline Certification Type Inspector Only

Certification Number 60 INSO 0712 3443

Issued To: Ian Pilling

Gender	Height		Weight	Date of Birth
Male	5	8	170	3/26/1973

Company

United Consulting

Address

625 Holcomb Bridge Road

City	State	Zip	Phone
Norcross	Georgia	30071	(770) 209-0029

Certification Issue Date	Certification Expiration Date	Last Date Of Training
7/23/2012	7/2/2013	7/2/2012

This certificate confers all authorities granted by Georgia EPD Rules 391-3-24 and allows the above named individual to serve as a(n)

Inspector Only

This certificate must be in your possession while conducting activities regulated by Georgia Rules 391-3-24. This certification is only valid for the performance of Georgia regulated lead-based paint activities and when employed by a Georgia Certified Lead-Based Paint Firm. A renewal application must be submitted at least thirty (30) days prior to the expiration date shown, and a refresher training course must be taken before the last date of training.

Issue Date	*Expiration Date*
7/23/2012	7/2/2013

Georgia Lead Firm License Number

60 INSO 0712 296

Mindy Cream, Program Manager
Lead-Based Paint and Asbestos Program
(404) 363-7026
Issued By Aljosie Larkins

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 102082-0

Analytical Environmental Services, Inc.

Atlanta, GA

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

BULK ASBESTOS FIBER ANALYSIS

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2011-10-01 through 2012-09-30

Effective dates

Sally S. Bruce

For the National Institute of Standards and Technology

NVLAP-01C (REV. 2009-01-28)

National Voluntary Laboratory Accreditation Program

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

Analytical Environmental Services, Inc.
3785 Presidential Parkway
Atlanta, GA 30340
Mr. Mehmet Yildirim
Phone: 770-457-8177 Fax: 770-457-8188
E-Mail: my@aesatlanta.com
URL: http://www.aesatlanta.com

BULK ASBESTOS FIBER ANALYSIS (PLM) **NVLAP LAB CODE 102082-0**

NVLAP Code	*Designation / Description*
18/A01	EPA-600/M4-82-020: Interim Method for the Determination of Asbestos in Bulk Insulation Samples

2011-10-01 through 2012-09-30
Effective dates

Sally S. Bruce
For the National Institute of Standards and Technology

APPENDIX C – LABORATORY RESULTS

ANALYTICAL ENVIRONMENTAL SERVICES, INC.
3785 Presidential Pkwy., Atlanta, GA 30340-3704
(770) 457-8177 / Toll Free (800) 972-4889 / Fax (770) 457-8188

1207H17

CHAIN OF CUSTODY
BULK ASBESTOS ANALYSIS

Client Name:	United Consulting	Phone:	678) 410-8474
Address:	625 Holcomb Br. Rd	Fax:	( )
City, State, Zip:	Norcross GA 30071	Project Name:	Liddell Dr
Contact:	Britt Bickerstaff	Project Number:	2012.3532.01
Sampler's Name:	Britt Bickerstaff	Sampling Date:	7/25/12

	Sample ID	Sample Location/Description	Analysis Requested	Turnaround Time	Comments	For AES Use Only
1	A-1	M-Bld interior insulation	PLM	Next Day		
2	A-2	M-Bld interior insulation paper	↓	↓		
3	A-3	M-Bld interior insulation				
4	A-4	M-Bld interior insulation paper				
5	A-5	M Bld exterior window caulk				
6	A-6	M Bld ext window caulk				
7	A-7	M Bld window glaze				
8	A-8	" "				
9	A-9	M Bld Roof Penetration mastic				
10	A-10	C Bld Black tar - Roof				
11	A-11	C Bld - roof - layer 1 tar				
12	A-12	C Bld - roof - layer 2 - shingle				
13	A-13	C Bld - roof - layer 3 - perlite				
14	A-14	C Bld - roof vent pipe tar				
15	A-15	C Bld - roof vent 2 pipe tar				
16	A-16	C Bld - roof - roll roofing w/ tar				
17	A-17	C Bld - felt paper layer 2				
18	A-18	C Bld - roof - perlite - layer 3				
19	A-19	C Bld - roof paneling				
20	A-20	C Bld - int. window glazing	↓	↓		

Relinquished by:	Britt Bickerstaff	Date/Time:	7/25/12 5:17 p
Received by:		Date/Time:	
Relinquished by:		Date/Time:	
Received by:		Date/Time:	

FOR LAB USE ONLY

Lab Recipient: Latoya P Date/Time: 7/25/12 5:17pm Method of Shipment: Client

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

3785 Presidential Pkwy., Atlanta, GA 30340-3704

(770) 457-8177 / Toll Free (800) 972-4889 / Fax (770) 457-8188

CHAIN OF CUSTODY

BULK ASBESTOS ANALYSIS

1207H17

Client Name: United Consulting Phone: (678) 410-8474

Address: 625 Holcomb Br. Rd Fax: ( )

City, State, Zip: Norcross GA, 30071 Project Name: Liddell Drive

Contact: Britt Bickerstaff Project Number: 2012.3532.01

Sampler's Name: Britt Bickerstaff Sampling Date: 7/25/12

	Sample ID	Sample Location/Description	Analysis Requested	Turnaround Time	Comments	For AES Use Only
1	A-21	C Bldg - Int. window glazing	PLM	next day		
2	A-22	C Bldg - Ext - roof panel				
3	A-23	C Bldg - Expansion joint caulk ext				
4	A-24	C Bldg - Ext window glazing				
5	A-25	C Bldg - Ext window glazing				
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						

Relinquished by: Britt Bickerstaff Date/Time: 7/25/12 5:17p

Received by: Date/Time:

Relinquished by: Date/Time:

Received by: Date/Time:

FOR LAB USE ONLY

Lab Recipient Latoya P Date/Time 7/25/12 5:17pm Method of Shipment Client

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

Bulk Sample Summary Report

NVLAP Lab ID# 102082-0

27-Jul-12

Client Name:	**United Consulting Group Inc.**	AES Job Number:	**1207H17**
Project Name:	**Liddell Drive**	Project Number:	**2012.3532.01**

Client ID	AES ID	Location	Asbestos Mineral Percentage						Comments
			CH	AM	CR	AN	TR	AC	
A-1 Layer: 1	1207H17 -001A	M - Bld Interior Insulation	ND	ND	ND	ND	ND	ND	
A-2 Layer: 1	1207H17 -002A	M - Bld Insulation Paper	ND	ND	ND	ND	ND	ND	
A-2 Layer: 2	1207H17 -002A	M - Bld Insulation Paper	ND	ND	ND	ND	ND	ND	
A-3 Layer: 1	1207H17 -003A	M - Bld Interior Insulation	ND	ND	ND	ND	ND	ND	
A-4 Layer: 1	1207H17 -004A	M - Bld Interior Insulation Paper	ND	ND	ND	ND	ND	ND	
A-4 Layer: 2	1207H17 -004A	M - Bld Interior Insulation Paper	ND	ND	ND	ND	ND	ND	
A-5 Layer: 1	1207H17 -005A	M Bld Exterior Window Caulk	ND	ND	ND	ND	ND	ND	

Note: CH=chrysotile, AM=amosite, CR=crocidolite, AC=actinolite, TR=tremolite, AN=anthophylite

For comments on the samples, see the individual analysis sheets.

ND = None Detected

PLM is not consistently reliable in detecting small concentrations of asbestos in floor tiles and similar nonfriable materials. Quantitative TEM is currently the only method that can be used to determine the conclusive asbestos content.

It is certified by the signatures below that the laboratory identified is accredited by the National Institute of Standards and Technology for Polarized Light Microscopy (PLM) analysis under the EPA Interim Asbestos Bulk Sample Quality Assurance Program, Laboratory ID 102082-0. All percentages given are by visually estimated volume. All analyses are performed in accordance with the EPA "Method for the Determination of Asbestos in Bulk Building Materials, EPA/600/R-93/116, July 1993." This report must not be reproduced except in full without the approval of Analytical Environmental Service, Inc. These test results apply only to the samples actually tested.

Microanalyst: Vira Ruiz

Vira Ruiz

QC Analyst:

Yelena Khanina

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

Bulk Sample Summary Report

NVLAP Lab ID# 102082-0

27-Jul-12

Client Name:	**United Consulting Group Inc.**	AES Job Number:	**1207H17**
Project Name:	**Liddell Drive**	Project Number:	**2012.3532.01**

Client ID	AES ID	Location	Asbestos Mineral Percentage						Comments
			CH	AM	CR	AN	TR	AC	
A-6 Layer: 1	1207H17 -006A	M Bld Ext Window Caulk	ND	ND	ND	ND	ND	ND	
A-7 Layer: 1	1207H17 -007A	M Bld Window Glaze	2	ND	ND	ND	ND	ND	
A-8 Layer: 1	1207H17 -008A	M Bld Window Glaze	2	ND	ND	ND	ND	ND	
A-9 Layer: 1	1207H17 -009A	M Bld Roof Penetration Mastic	15	ND	ND	ND	ND	ND	
A-10 Layer: 1	1207H17 -010A	C Bld Black Tar - Roof	ND	ND	ND	ND	ND	ND	
A-10 Layer: 2	1207H17 -010A	C Bld Black Tar - Roof	ND	ND	ND	ND	ND	ND	
A-10 Layer: 3	1207H17 -010A	C Bld Black Tar - Roof	ND	ND	ND	ND	ND	ND	

Note: CH=chrysotile, AM=amosite, CR=crocidolite, AC=actinolite, TR=tremolite, AN=anthophylite

For comments on the samples, see the individual analysis sheets.

ND = None Detected

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Microanalyst: Vira Ruiz

QC Analyst: Yelena Khanina

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

Bulk Sample Summary Report

NVLAP Lab ID# 102082-0

27-Jul-12

Client Name:	**United Consulting Group Inc.**	AES Job Number:	**1207H17**
Project Name:	**Liddell Drive**	Project Number:	**2012.3532.01**

Client ID	AES ID	Location	Asbestos Mineral Percentage						Comments
			CH	AM	CR	AN	TR	AC	
A-11 Layer: 1	1207H17 -011A	C Bld - Roof - Layer 1 Tar	ND	ND	ND	ND	ND	ND	
A-11 Layer: 2	1207H17 -011A	C Bld - Roof - Layer 1 Tar	ND	ND	ND	ND	ND	ND	
A-12 Layer: 1	1207H17 -012A	C Bld - Roof - Layer 2 Shingle	ND	ND	ND	ND	ND	ND	
A-12 Layer: 2	1207H17 -012A	C Bld - Roof - Layer 2 Shingle	ND	ND	ND	ND	ND	ND	
A-13 Layer: 1	1207H17 -013A	C Bld - Roof - Layer 3 Perlite	ND	ND	ND	ND	ND	ND	
A-14 Layer: 1	1207H17 -014A	C Bld - Roof - Vent 1 Pipe Tar	ND	ND	ND	ND	ND	ND	
A-14 Layer: 2	1207H17 -014A	C Bld - Roof - Vent 1 Pipe Tar	20	ND	ND	ND	ND	ND	

Note: CH=chrysotile, AM=amosite, CR=crocidolite, AC=actinolite, TR=tremolite, AN=anthophylite

For comments on the samples, see the individual analysis sheets.

ND = None Detected

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Microanalyst: Vira Ruiz

QC Analyst: Yelena Khanina

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

Bulk Sample Summary Report

NVLAP Lab ID# 102082-0

27-Jul-12

Client Name:	**United Consulting Group Inc.**	AES Job Number:	**1207H17**
Project Name:	**Liddell Drive**	Project Number:	**2012.3532.01**

Client ID	AES ID	Location	Asbestos Mineral Percentage						Comments
			CH	AM	CR	AN	TR	AC	
A-15 Layer: 1	1207H17 -015A	C Bld - Roof - Vent 2 Pipe Tar	20	ND	ND	ND	ND	ND	
A-16 Layer: 1	1207H17 -016A	C Bld - Roof - Roll Roofing w / Tar	ND	ND	ND	ND	ND	ND	
A-16 Layer: 2	1207H17 -016A	C Bld - Roof - Roll Roofing w / Tar	ND	ND	ND	ND	ND	ND	
A-17 Layer: 1	1207H17 -017A	C Bld - Felt Paper - Layer 2	ND	ND	ND	ND	ND	ND	
A-18 Layer: 1	1207H17 -018A	C Bld - Felt Paper - Layer3	ND	ND	ND	ND	ND	ND	
A-19 Layer: 1	1207H17 -019A	C Bld - Roof Paneling	20	ND	ND	ND	ND	ND	
A-20 Layer: 1	1207H17 -020A	C Bld - Int. Window Glazing	2	ND	ND	ND	ND	ND	Paint included as binder

Note: CH=chrysotile, AM=amosite, CR=crocidolite, AC=actinolite, TR=tremolite, AN=anthophylite

For comments on the samples, see the individual analysis sheets.

ND = None Detected

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Microanalyst: Vira Ruiz

QC Analyst: Yelena Khanina

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

Bulk Sample Summary Report

NVLAP Lab ID# 102082-0

27-Jul-12

Client Name: **United Consulting Group Inc.** AES Job Number: **1207H17**

Project Name: **Liddell Drive** Project Number: **2012.3532.01**

Client ID	AES ID	Location	Asbestos Mineral Percentage						Comments
			CH	AM	CR	AN	TR	AC	
A-21 Layer: 1	1207H17 -021A	C Bld - Int. Window Glazing	2	ND	ND	ND	ND	ND	Paint included as binder
A-22 Layer: 1	1207H17 -022A	C Bld - Int. Roof Panel	20	ND	ND	ND	ND	ND	
A-23 Layer: 1	1207H17 -023A	C Bld - Expansion Joint Caulk Ext	15	ND	ND	ND	ND	ND	Paint included as binder
A-24 Layer: 1	1207H17 -024A	C Bld - Ext Window Glazing	15	ND	ND	ND	ND	ND	Paint included as binder
A-25 Layer: 1	1207H17 -025A	C Bld - Ext Window Glazing	15	ND	ND	ND	ND	ND	Paint included as binder

Note: CH=chrysotile, AM=amosite, CR=crocidolite, AC=actinolite, TR=tremolite, AN=anthophylite

For comments on the samples, see the individual analysis sheets.

ND = None Detected

PLM is not consistently reliable in detecting small concentrations of asbestos in floor tiles and similar nonfriable materials. Quantitative TEM is currently the only method that can be used to determine the conclusive asbestos content.

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Microanalyst: Vira Ruiz

QC Analyst: Yelena Khanina

AES

ANALYTICAL ENVIRONMENTAL SERVICES, INC.

July 28, 2012

Ian Pilling
United Consulting Group Inc.
625 Holcomb Bridge Rd
Norcross GA 30071

TEL: (770) 582-2788
FAX: (770) 582-2900

RE: Liddell Drive Equalization Project

Dear Ian Pilling:

Order No: 1207H65

Analytical Environmental Services, Inc. received 6 samples on July 26, 2012 9:10 am for the analyses presented in following report.

No problems were encountered during the analyses. Additionally, all results for the associated Quality Control samples were within EPA and/or AES established limits. Any discrepancies associated with the analyses contained herein will be noted and submitted in the form of a project Case Narrative.
AES' certifications are as follows:
-NELAC/Florida Certification number E87582 for analysis of Environmental Water, soil/hazardous waste, and Drinking Water Microbiology, effective 07/01/12-06/30/13.
-AIHA Certification ID #100671 for Industrial Hygiene samples (Organics, Inorganics), Environmental Lead (Paint, Soil, Dust Wipes, Air), and Environmental Microbiology (Fungal) effective until 09/01/13.

These results relate only to the items tested. This report may only be reproduced in full.

If you have any questions regarding these test results, please feel free to call.

Kathryn E. Waters

Kathryn Waters
Project Manager

ANALYTICAL ENVIRONMENTAL SERVICES, INC
3785 Presidential Parkway, Atlanta GA 30340-3704
AES TEL.: (770) 457-8177 / TOLL-FREE (800) 972-4889 / FAX: (770) 457-8188

CHAIN OF CUSTODY

Work Order: 1207H65

Date: 7/24/12 Page ____ of ____

COMPANY: United Consulting
ADDRESS: 625 Holcomb Bridge
PHONE: (7) 582-7816
FAX:
SAMPLED BY: Ian P. Illing
SIGNATURE:

#	SAMPLE ID	SAMPLED DATE	SAMPLED TIME	Grab	Composite	Matrix (See codes)	PRESERVATION (See codes)	No # of Containers
1	L-1	7/24/12				Paint	X	
2	L-2						X	
3	L-3						X	
4	L-4						X	
5	L-5						X	
6	L-6						X	
7								
8								
9								
10								
11								
12								
13								
14								

ANALYSIS REQUESTED: Pb

REMARKS

Visit our website www.aesatlanta.com to check on the status of your results, place bottle orders, etc.

RELINQUISHED BY	DATE/TIME	RECEIVED BY	DATE/TIME
1:	7/24/12 3:55pm	1:	7/24/12 3:55pm
2:	7/26/12 8:35	2: Reid	7/25/12 8:35
3: Reid	7/25/12 9:10am	3: Latoya P	7/26/12 9:10am

PROJECT INFORMATION
PROJECT NAME: Lidwell Ave
PROJECT #: 2012.3532.01
SITE ADDRESS:
SEND REPORT TO: Ian Illing
INVOICE TO: (IF DIFFERENT FROM ABOVE)
QUOTE #: PO#:

RECEIPT
Total # of Containers

Turnaround Time Request
- ○ Standard 5 Business Days
- ○ 2 Business Day Rush
- ⊗ Next Business Day Rush
- ○ Same Day Rush (auth req.)
- ○ Other ____

STATE PROGRAM (if any): ____
E-mail? Y / N: Fax? Y / N
DATA PACKAGE: I II III IV

SPECIAL INSTRUCTIONS/COMMENTS:

SHIPMENT METHOD
OUT / / VIA:
IN / / VIA:
(CLIENT) FedEx UPS MAIL COURIER
GREYHOUND OTHER ____

SAMPLES RECEIVED AFTER 3PM OR ON SATURDAY ARE CONSIDERED RECEIVED THE NEXT BUSINESS DAY. IF TURNAROUND TIME IS NOT INDICATED, AES WILL PROCEED WITH STANDARD TAT OF SAMPLES.
SAMPLES ARE DISPOSED 30 DAYS AFTER REPORT COMPLETION UNLESS OTHER ARRANGEMENTS ARE MADE.

MATRIX CODES: A = Air GW = Groundwater SE = Sediment SO = Soil SW = Surface Water W = Water (Blanks) DW = Drinking Water (Blanks) O = Other (specify) WW = Waste Water
PRESERVATIVE CODES: H+I = Hydrochloric acid + ice I = Ice only N = Nitric acid S+I = Sulfuric acid + ice S/M+I = Sodium Bisulfate/Methanol + ice O = Other (specify) NA = None

White Copy - Original; Yellow Copy - Client

Page 2 of 6

Analytical Environmental Services, Inc

Date: 28-Jul-12

Lab Order:	1207H65
Client:	United Consulting Group Inc.
Project:	Liddell Drive Equalization Project
Matrix:	Paint
Date Received:	7/26/2012 9:10:00 AM

TOTAL LEAD IN PAINT (N7082)

PAINT

Laboratory ID	Client Sample ID	Result	Units	Reporting Limit	DF	Qual	Date Collected	Date Analyzed	Analyst
1207H65-001A	L-1	1.36	wt%	0.197	20.2		07/24/2012	07/27/2012	MW
1207H65-002A	L-2	0.110	wt%	0.00914	1		07/24/2012	07/27/2012	MW
1207H65-003A	L-3	1.30	wt%	0.150	16.09		07/24/2012	07/27/2012	MW
1207H65-004A	L-4	0.180	wt%	0.00977	1		07/24/2012	07/27/2012	MW
1207H65-005A	L-5	0.0753	wt%	0.00954	1		07/24/2012	07/27/2012	MW
1207H65-006A	L-6	15.4	wt%	0.918	100		07/24/2012	07/27/2012	MW

Qualifiers: BRL - Not Detected at the Reporting Limit

B - Analyte detected in the associated Method Blank

DF - Dilution Factor

Results are blank corrected where applicable

Analytical Environmental Services, Inc.

Sample/Cooler Receipt Checklist

Client United Consulting Work Order Number 1207H65

Checklist completed by Catalya P 7/26/12
Signature Date

Carrier name: FedEx __ UPS __ Courier __ Client ✓ US Mail __ Other _____

Shipping container/cooler in good condition? Yes ✓ No __ Not Present __

Custody seals intact on shipping container/cooler? Yes __ No __ Not Present ✓

Custody seals intact on sample bottles? Yes __ No __ Not Present ✓

Container/Temp Blank temperature in compliance? (4°C±2)* Yes ✓ No __ cp 7/26/12

Cooler #1 Ambient Cooler #2 _____ Cooler #3 _____ Cooler #4 _____ Cooler#5 _____ Cooler #6 _____

Chain of custody present? Yes ✓ No __

Chain of custody signed when relinquished and received? Yes ✓ No __

Chain of custody agrees with sample labels? Yes ✓ No __

Samples in proper container/bottle? Yes ✓ No __

Sample containers intact? Yes ✓ No __

Sufficient sample volume for indicated test? Yes ✓ No __

All samples received within holding time? Yes ✓ No __

Was TAT marked on the COC? Yes ✓ No __

Proceed with Standard TAT as per project history? Yes __ No __ Not Applicable ✓

Water - VOA vials have zero headspace? No VOA vials submitted ✓ Yes __ No __

Water - pH acceptable upon receipt? Yes __ No __ Not Applicable ✓

Adjusted? _____ Checked by _____

Sample Condition: Good ✓ Other(Explain) _____

(For diffusive samples or AIHA lead) Is a known blank included? Yes __ No ✓

See Case Narrative for resolution of the Non-Conformance.

* Samples do not have to comply with the given range for certain parameters.

I:\Quality Assurance\Checklists Procedures Sign-Off Templates\Checklists\Sample Receipt Checklists\Sample_Cooler_Receipt_Checklist

Analytical Environmental Services, Inc

Date: 28-Jul-12

Client: United Consulting Group Inc.
Project: Liddell Drive Equalization Project
Lab Order: 1207H65

Dates Report

Lab Sample ID	Client Sample ID	Collection Date	Matrix	Test Name	TCLP Date	Prep Date	Analysis Date
1207H65-001A	L-1	7/24/2012 12:00:00AM	Paint	TOTAL LEAD IN PAINT (N7082)		07/26/2012	07/27/2012
1207H65-002A	L-2	7/24/2012 12:00:00AM	Paint	TOTAL LEAD IN PAINT (N7082)		07/26/2012	07/27/2012
1207H65-003A	L-3	7/24/2012 12:00:00AM	Paint	TOTAL LEAD IN PAINT (N7082)		07/26/2012	07/27/2012
1207H65-004A	L-4	7/24/2012 12:00:00AM	Paint	TOTAL LEAD IN PAINT (N7082)		07/26/2012	07/27/2012
1207H65-005A	L-5	7/24/2012 12:00:00AM	Paint	TOTAL LEAD IN PAINT (N7082)		07/26/2012	07/27/2012
1207H65-006A	L-6	7/24/2012 12:00:00AM	Paint	TOTAL LEAD IN PAINT (N7082)		07/26/2012	07/27/2012

Analytical Environmental Services, Inc

Date: 28-Jul-12

Client: United Consulting Group Inc.
Project Name: Liddell Drive Equalization Project
Workorder: 1207H65

ANALYTICAL QC SUMMARY REPORT

BatchID: 164355

Sample ID: MB-164355	Client ID:					Units: wt%		Prep Date: 07/26/2012		Run No: 225829	
SampleType: MBLK	TestCode: TOTAL LEAD IN PAINT (N7082)					BatchID: 164355		Analysis Date: 07/26/2012		Seq No: 4727105	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	BRL	0.0100	0	0	0	0	0	0	0	0	

Sample ID: LCS-164355	Client ID:					Units: wt%		Prep Date: 07/26/2012		Run No: 225829	
SampleType: LCS	TestCode: TOTAL LEAD IN PAINT (N7082)					BatchID: 164355		Analysis Date: 07/26/2012		Seq No: 4727108	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	0.6287	0.116	0.7405	0.001670	84.7	80	120	0	0	0	

Sample ID: 1207H33-002AMS	Client ID:					Units: ppm		Prep Date: 07/26/2012		Run No: 225829	
SampleType: MS	TestCode: TOTAL LEAD IN PAINT (N7082)					BatchID: 164355		Analysis Date: 07/26/2012		Seq No: 4727115	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	3849	91.5	4575	31.53	83.5	75	125	0	0		

Sample ID: 1207H33-002AMSD	Client ID:					Units: ppm		Prep Date: 07/26/2012		Run No: 225829	
SampleType: MSD	TestCode: TOTAL LEAD IN PAINT (N7082)					BatchID: 164355		Analysis Date: 07/26/2012		Seq No: 4727118	
Analyte	Result	RPT Limit	SPK value	SPK Ref Val	%REC	Low Limit	High Limit	RPD Ref Val	%RPD	RPD Limit	Qual
Lead	3984	93.8	4690	31.53	84.3	75	125	3849	3.43	25	

Qualifiers:

>	Greater than Result value	<	Less than Result value	B	Analyte detected in the associated method blank
BRL	Below reporting limit	E	Estimated (value above quantitation range)	H	Holding times for preparation or analysis exceeded
J	Estimated value detected below Reporting Limit	N	Analyte not NELAC certified	R	RPD outside limits due to matrix
Rpt Lim	Reporting Limit	S	Spike Recovery outside limits due to matrix		