Vol 1

SAVANNAH
Public Works & Water Resources

BIDDING, CONTRACT DOCUMENTS AND TECHNICAL SPECIFICATIONS FOR THE CONSTRUCTION OF

TRAVIS FIELD WATER RECLAMATION FACILITY

CIP# SW-524-10

FOR

THE CITY OF SAVANNAH, GEORGIA

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CITY MANAGER	ROBERTO HERNANDEZ

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MAY 2019

PREPARED BY:

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BID SET - NOT FOR CONSTRUCTION

SECTION 32 11 23

AGGREGATE BASE COURSE

PART 1 – GENERAL

1.01 SECTION INCLUDES

Aggregate base course.

1.02 RELATED SECTIONS

A. Section 0145 00 - Quality Control.

B. Section 31 00 00 - Earthwork

C. Section 32 12 16 ga - Asphaltic Concrete Binder/Surface Courses: Binder and finish asphalt courses.

1.03 MEASUREMENT AND PAYMENT

Aggregate Base Course: Payment will be included in the contract lump sum price. Payment will include supplying all material, labor, and equipment, stockpiling, scarifying substrate surface, placing where required, and compacting.

1.04 REFERENCES (LATEST REVISION)

A. ASTM C 131 – Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Lost Angeles Machine.

B. ASTM D 1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort.

C. ASTM D 2922 – Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

D. ASTM D 6938 – In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

E. ASTM D 3740 – Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction.

F. ASTM E 329 – Agencies Engaged in Construction Inspection and/or Testing.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with the Georgia Department of Transportation 2013 Standard Specifications for Highway Construction.

B. Source Quality Control Measures:

1. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

2. Final approval of aggregate material will be based on test results of installed materials.

3. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

1.06 TESTING

A. Laboratory tests for moisture density relationship for fill materials shall be in accordance with ASTM D 1557, (Modified Proctor).

B. In place density tests in accordance with ASTM D 1556 or ASTM D 2922.

C. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

D. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours notice prior to taking any tests.

E. Owner shall select and engage the Testing Laboratory. Testing Laboratory shall be responsible to the Owner and Owner's Engineer. Payment for laboratory and all tests shall be by the Owner, except Owner specifically reserves the right to deduct from Contractor's payment, expenses and charges of Testing Laboratory when:

   1. Contractor gives notice the work is ready for inspection and testing, and fails to be ready for the test, and/or

   2. Testing of the Contractor's work, products, or materials fail, and retesting is required, and/or

   3. Contractor abuses the services or interferes with the work of the testing laboratory in the conduct of this work.

F. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

1.07 SUBMITTALS

A. Informational Submittals

   1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

   2. Certified results of in-place density tests from independent testing agency.

PART 2 – PRODUCTS

2.01 MATERIALS

Aggregate shall consist of processed and blended crushed stone. Aggregates shall be free from lumps and balls of clay, organic matter, objectionable coatings, and other foreign material and shall be durable and sound. Coarse aggregate shall have a percentage of wear not to exceed 65% after 500 revolutions as determined by ASTM C 131. Aggregate shall meet applicable requirements of Section 305.2 in the Georgia Department of Transportation Standard 2013 Specifications for Highway Construction. Material shall meet the following gradation and other requirements:

Granite Stone or Recycled Concrete	
Sieve Size	Percent by Weight Passing
2"	100
1-1/2"	95 - 100
1"	70 - 100
1/2"	48 - 75
# 4	30 - 60
# 30	11 - 30
#200	0 - 12
Liquid Limit	0 to 25
Plasticity Index	0 to 6

2.02 EQUIPMENT

A. Equipment shall be in accordance with the Georgia Department of Transportation Standard 2013 Specifications for Highway Construction.

B. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify subbase has been tested, is dry, and slopes and elevations are correct.

B. ON SITE OBSERVATIONS OF WORK: The Owner's Representative or Engineer will have the right to require any portion of the work be completed in their presence and if the work is covered up after such instruction, it shall be exposed by the Contractor for observation at no additional cost to the Owner. However, if the Contractor notifies the Owner such work is scheduled, and the Owner or Engineer fails to appear within 72 hours, the Contractor may proceed. All work completed and materials furnished shall be subject to review by the Owner, Engineer or Project Representative. Improper work shall be reconstructed, and all materials, which do not conform to the requirements of the specifications, shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

C. Contractor shall give the Owner, Project Engineer or Project Representative a minimum of 72 hours notice for all required observations or tests.

3.02 PREPARATION

A. Subbase shall be graded and shaped conforming to the lines, grades, and cross sections required and cleaned of all foreign substances prior to constructing base course. Do not place base on soft, muddy or frozen surfaces. Correct irregularities in subbase slope and elevation by scarifying, reshaping, and recompacting.

B. At the time of base course construction, subbase shall contain no frozen material.

C. Surface of subbase shall be checked by the Engineer or Project Representative for adequate compaction and surface tolerances. Ruts or soft yielding spots appearing in areas of subbase course having inadequate compaction, and areas not smooth or which vary in elevation more than 3/8-inch above or below required grade established on the plans, shall be corrected to the satisfaction of the Engineer or Project Representative. Base material shall not be placed until subbase has been properly prepared and test results have so indicated.

D. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.

E. Hauling:

1. Do not haul over surfacing in process of construction.

2. Loads: Of uniform capacity.

3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

3.03 AGGREGATE PLACEMENT

A. Aggregate shall be placed in accordance with Georgia Department of 2013 Transportation Standard Specifications for Highway Construction Section 305 and in accordance with these specifications.

B. Maximum lift thickness of Aggregate Base Course shall be six (6) inches. Maximum lift thickness of Gravel Surfacing shall be nine (9) inches. Place and compact each lift to required density before succeeding lift is placed.

C. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.

D. Produce even distribution of material upon roadway or prepared surface without segregation. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

E. Level and contour surfaces to elevations and slopes indicated on the Drawings.

F. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

G. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

H. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

I. While at optimum moisture (± 1-1/2%), compact base course with rollers capable of obtaining required density. Vibratory, flatwheel, and other rollers accepted by the Engineer may be used to obtain required compaction. Rolling shall continue until base is compacted to 100% of the modified Proctor maximum laboratory dry density as determined by ASTM D 1557. In-place density of the compacted base shall be determined in accordance with ASTM D 2922.

J. Base shall be allowed to cure at least 15 days after the acceptable completion tests are achieved before paving.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with an acceptable 10-foot straight edge.

B. Scheduled Compacted Thickness: Within 3/8 inch.

C. Variation from Design Elevation: Within 3/8 inch.

D. Depth measurements for compacted thickness shall be made by test holes through the base course. Where base course is deficient, correct such areas by scarifying, adding base material and recompacting as directed by the Engineer.

3.05 FIELD QUALITY CONTROL

A. Density and moisture testing will be performed in accordance with ASTM D 1557, ASTM D 2922, and ASTM D 6938.

B. See Table below for minimum sampling and testing requirements for aggregate base course and surfacing:

Minimum Sampling and Testing Requirements			
Property	**Test Method**	**Frequency**	**Sampling Point**
Gradation	AASHTO T11 and AASHTOT27	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	AASHTO T180, Method D	One test for every aggregate grading produced	Production output of stockpile
In-place Density and Moisture Content	AASHTO T310 and AASHTO T265 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

D. Frequency of Tests:

Base Density and Thickness - One test per 5,000 square feet.

END OF SECTION

INDEX TO

SECTION 32 12 16GA

ASPHALT PAVING

SECTION 32 12 16GA

ASPHALT PAVING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Surface Course

B. Binder Course

1.02 RELATED SECTIONS

A. Section 01 45 00 – Quality Control

B. Section 31 23 13 – Subgrade Preparation

C. Section 31 23 23 – Fill and Backfill

D. Section 32 11 23 – Aggregate Base Courses

1.03 OMITTED

1.04 REFERENCES (LATEST REVISION)

A. ASTM D 946 – Penetration–Graded Asphalt–Cement for Use in Pavement Construction.

B. ASTM E 329 – Agencies Engaged in Construction Inspection and/or Testing.

C. ASTM D 3740 – Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock Used in Engineering Design and Construction.

D. ASTM D 2726 – Bulk Specific Gravity and Density of Non–Absorptive Compacted Bituminous Mixtures.

E. ASTM D 2950 – Density of Bituminous Concrete in Place by Nuclear Methods.

F. ASTM D 1188 – Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples.

G. ASTM D 1754 – Effect of Heat and Air on Asphaltic Materials (Thin–film Oven Test).

1.05 QUALITY ASSURANCE

A. Perform work in accordance with Georgia Department of Transportation 2013 Standard Specifications for Highway Construction.

B. Mixing Plant: Conform to Georgia Department of Transportation 2013 Standard Specifications for Highway Construction.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Do not place asphalt mixture when ambient air temperature is less than that indicated in the Table nor when the surface is wet or frozen.

Lift Thickness	Min. Air Temperature, Degrees F.
1" or Less	55
1.1" to 2"	45
2.1" to 3"	40
3.1" to 4.5"	35

B. Mixture shall be delivered to the spreader at a temperature between 250 degrees F and 325 degrees F.

1.07 GUARANTEE

A. Contractor shall guarantee the quality of materials, equipment, and workmanship for a period of 12 months after acceptance. Defects discovered during this period shall be repaired by the Contractor at no cost to the Owner.

1.08 TESTING

A. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

B. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours notice prior to taking any tests.

C. Owner shall select and engage the testing laboratory. Testing laboratory shall be responsible to the Owner and Owner's Engineer. Payment for laboratory and all tests shall be by the Owner, except Owner specifically reserves the right to deduct from Contractor's payment, expenses and charges of testing laboratory when:

1. Contractor gives notice the work is ready for inspection and testing, and fails to be ready for the test, and/or

2. Testing of the Contractor's work, products or materials fail, and retesting is required, and/or

3. Contractor abuses the services or interferes with the work of the testing laboratory in the conduct of this work.

D. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

PART 2 – PRODUCTS

2.01 TACK COAT

A. Shall consist of asphalt binder (asphalt cement) or emulsified asphalt, conforming to Section 401 of the Georgia Department of Transportation 2013 Standard Specifications for Highway Construction. Asphalt binder shall be PG64–22. The acceptable grades of emulsified asphalt are RS–1, MS–1, MS–2, HFMS–1, HFMS–2, SS–1, CRS–1, CRS–2, CMS–2, and CSS–1.

2.02 ASPHALT BINDER AND ADDITIVES

A. Shall be PG64–22 and conform to Section 401 of the Georgia Department of Transportation 2013 Standard Specifications for Highway Construction.

B. Anti–Stripping: Shall conform to requirements of Section 401 of the Georgia Department of Transportation 2013 Standard Specifications for Highway Construction.

2.03 AGGREGATES

A. General: Mineral aggregate shall be composed of fine aggregate or a combination of fine and coarse aggregate. Coarse aggregate shall be that portion of the material retained on a No. 4 sieve.

Fine aggregate shall be considered that portion passing the No. 200 sieve. Fine aggregate, coarse aggregate, and any additives in combination with the specified percentage of asphalt cement shall meet the requirements of tests specified, before acceptance may be given for their individual use. Marine (Fossiliferous) limestone shall not be used.

B. Fine Aggregate: Shall conform to the requirements of Section 401 of the Georgia Department of Transportation Standard Specifications for Highway Construction.

C. Coarse Aggregate: Shall be granite stone and conform to the requirements of Section 401 of the Georgia Department of Transportation 2013 Standard Specifications for Highway Construction.

D. Surface Course: The surface course shall consist of fine and coarse aggregate and mineral filler uniformly mixed with hot asphalt binder in an acceptable mixing plant. The plant shall conform to Georgia Department of Transportation 2013 Standard Specifications for Highway Construction. The gradations, asphalt content and air voids shall be the following:

TYPE C	
Square Sieve	% Passing
3/4 inch	100
1/2 inch	97 – 100
3/8 inch	83 – 100
No. 4	58 – 80
No. 8	42 – 62
No. 30	20 – 40
No. 100	8 – 20
No. 200	3 – 9
% Asphalt Binder	5.0 – 6.8
Air Voids, %	3.5 – 4.5

E. Intermediate or Binder Course: The mineral aggregates and asphalt binder shall be combined in such proportions the composition by weight of the finished mixture shall be within the following range limits:

TYPE B	
Sieve Designation	Percentage by Weight Passing
1 inch	100
3/4 inch	90 – 100
1/2 inch	75 – 90
3/8 inch	64 – 80
No. 4	38 – 54
No. 8	22 – 36
No. 30	8 – 22
No. 100	3 – 10
No. 200	2 – 8
% Asphalt Binder	4 – 6
Air Voids, %	– 4.5

2.04 SOURCE QUALITY CONTROL AND TESTS

A. Section 01 45 00 – Quality Control.

B. Submit proposed mix design for review prior to beginning of work.

C. Test samples in accordance with the requirements of these specifications.

PART 3 – EXECUTION

3.01 EXAMINATION

A. On–Site Observations: Owner's Representative or Engineer will have the right to require any portion of work be completed in their presence. If work is covered up after such instruction, it shall be exposed by the Contractor for observation at no additional cost to Owner. However, if Contractor notifies Engineer such work is scheduled, and Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed. All materials, which do not conform to requirements of specifications, shall be removed from the work upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

Contractor shall give the Owner, Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

B. Contractor shall verify base has been tested, is dry, and slopes and elevations are correct.

3.02 PREPARATION

A. Apply tack coat in accordance with Section 401 of the South Carolina Department of Transportation 2007 Standard Specifications for Highway Construction. Rate of application shall be 0.05 to 0.15 gallons per square yard of surface.

B. Work shall be planned so no more tack coat than is necessary for the day's operation is placed on the surface. All traffic not essential to the work should be kept off the tack coat.

C. Apply tack coat to contact surfaces of curbs and gutters. Apply in manner so exposed curb or gutter surfaces are not stained.

D. Coat surfaces of manhole frames and inlet frames with oil to prevent bond with asphalt pavement. Do <u>not</u> tack coat these surfaces.

3.03 PLACEMENT

A. Construction shall be in accordance with Sections 401, 402, and 403 of the Georgia Department of Transportation 2013 Standard Specifications for Highway Construction.

B. Asphaltic concrete shall not be placed on a wet or frozen surface.

C. Compaction shall commence as soon as possible after the mixture has been spread to the desired thickness. Compaction shall be continuous and uniform over the entire surface. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks. Compaction rolling shall be complete before material temperature drops below 175° F.

D. Areas of pavement with deficient thickness or density shall be removed and replaced at no additional cost to the Owner.

3.04 TOLERANCES

A. General: All paving shall be subject to visual and straightedge evaluation during construction operations and thereafter prior to final acceptance. A 10–foot straightedge shall be maintained in the vicinity of the paving operation at all times for the purpose of measuring surface irregularities on all paving courses. The straightedge and labor for its use shall be provided by the Contractor. The surface of all courses shall be checked with the straightedge as necessary to detect surface irregularities. Irregularities such as rippling, tearing or pulling, which in the judgment of the Engineer indicate a continuing problem in equipment, mixture or operating technique, will not be permitted to recur. The paving operation shall be stopped until appropriate steps are taken by the Contractor to correct the problem.

B. Flatness: All irregularities in excess of 1/8 inch in 10 feet for surface courses and 1/4 inch in 10 feet for intermediate courses shall be corrected.

C. Variation from Design Elevation:

1. General Paving: Less than 1/4 inch.

2. Accessible Routes: Shall not exceed 1/4 inch. However, accessible routes shall not exceed maximum ADA allowable slopes. Contractor shall remove and replace any and all portions of the accessible route that exceed maximum ADA allowable slopes.

D. Scheduled Compacted Thickness: Within 1/4 inch per lift.

E. Pavement Deficient in Thickness: When measurement of any core indicates the pavement is deficient in thickness, additional cores will be drilled 10 feet either side of the deficient core along the centerline of the lane until the cores indicate the thickness conforms to the above specified requirements. A core indicating thickness deficiencies is considered a failed test. Pavement deficient in thickness shall be removed and replaced with the appropriate thickness of materials. If the Contractor believes the cores and measurements taken are not sufficient to indicate fairly the actual thickness of the pavement, additional cores and measurements will be taken, provided the Contractor will bear the extra cost of drilling the cores and filling the holes in the roadway as directed.

3.05 FIELD QUALITY CONTROL

A. Acceptance of the in–place density of the binder and surface courses shall be in accordance with the Georgia Department of Transportation 2013Standard Specifications for Highway Construction.

B. Density Testing: Performed in accordance with ASTM D–2726 and ASTM D–2950. Core samples for each day's operation shall be taken, tested and results reported to the Engineer the following day. The areas sampled shall be properly restored by the Contractor at no additional cost to the Owner. Nuclear gauge tests shall be taken during the asphaltic concrete placement.

   1. The pavement core and nuclear gauge densities shall range between 94% and 96% of the theoretical maximum laboratory density.

C. Temperature:

   1. Asphaltic concrete shall not exceed 325 degrees F at any time.

   2. Asphaltic concrete shall not be placed once the temperature of the mix falls below 250 degrees F or the delivered temperature is more than 15 degrees F below the batch plant's delivery ticket.

   3. Temperature at time of loading shall be recorded on the truck delivery ticket.

D. Frequency of Tests:

   1. Asphaltic Concrete – One test for each 250 tons placed.

      a. Asphalt extraction and gradation test.

      b. Core Sample

   2. Field determination of density by nuclear method every 5,000 square feet during construction of the asphaltic concrete binder/surface course.

END OF SECTION

INDEX TO

SECTION 32 31 18 – CHAIN LINK FENCING AND ELECTIC GATES

Section 32 31 18

CHAIN LINK FENCING AND ELECTRIC GATES

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Furnish and install chain link fence around the entire site as shown on the Drawings. Fencing to include one manual personnel gate, one electric operated vehicular gates, one manual vehicular gate and all necessary materials, equipment and accessories.

B. Furnish and install a complete microprocessor based vehicular swing gate operators system, with a solid-state board to control all functions of the swing operator, as described herein and shown on the Drawings. Include all necessary boards, power supplies, special mounting hardware, connectors and accessories for a complete operational system.

C. Furnish and install one (1) electric access key pads at the electric operated vehicular gates.

1.02 CONTRACT DOUCMENTS

A. All equipment and work specified in this section shall comply, with all General Conditions of the specifications, contract documents and Drawings as indicated.

1.03 RELATED WORK

A. Contractor is responsible for the complete installation of all fencing and electric gates.

B. Contractor is responsible for the complete installation of all necessary electrical and controls prior to paving of the plant entrance road of the plant site roads.

I .04 QUALITY ASSURANCE

A. Installation shall comply with all applicable codes.

B. All equipment shall be new, in current production, and the standard products of a manufacturer of polymer Coated Steel Fabric ASTM F668. Metallic coated steel core wire Class 2b fused and adhered black color in compliance with ASTMF934.

C. Manufacturer shall guarantee availability of parts, for a minimum of seven (7) years from date of acceptance of installation.

D. Manufacturer is shall demonstrate features, functions, and operating characteristics to the Owner prior to acceptance of installation.

E. Fencing system shall be installed by a factory trained authorized contractor who has sold, installed, maintained and serviced this type of system for at least five (5) years, and who employs technicians specifically trained in this system.

F. On-site maintenance and repair service shall be available locally 24 hours per day, 7 days per week, and within four (4) hours of notification for emergency condition.

1.05 REFERENCED STANDARDS

A. Vehicular Swing Gate Operator shall be in compliance with the Underwriter Laboratories Inc. (UL) Standard for Safety — Door, Drapery, Gate, Louver and .Window Operators and Systems, UL 325 Fourth Edition; and Underwriter Laboratories Inc. (UL) Standard for Safety — Tests for Safety-Related Controls Employing Solid-State Devices, UL 991 Second Edition.

B. Vehicular Swing Gate Operator shall be tested for compliance to the UL 325 and UL 991 and shall be LISTED by the Nationally Recognized Testing Laboratory (NRTL).

1.06 SUBMITTALS

A. Provisions: Submittals shall comply with the Submittal Procedure Section 01 33 00.

B. Shall include an equipment list, data sheets, system description, block diagrams on equipment to be furnished and electrical wiring diagrams for installation.

C. Shall include all data necessary to evaluate design, quality and configuration of the proposed equipment and system(s).

1.07 WARRANTY

A. Systems shall include a factory warranty that equipment is free from defects in design, material, manufacturing and operation.

B. Factory warranty period shall be for two (2) years parts and workmanship; 24months from date of acceptance of installation.

C. Contractor shall guarantee the equipment, wire and installation for 12-months from the date of acceptance of installation.

PART 2 – PRODUCTS

2.01 FENCING AND GATES

A. Fencing shall have an overall height of 8 feet (seven-foot-tall fabric with three strands of barbed wire), standard FE security fence construction, 2 h" OD schedule 40 galvanized steel line posts, 3" OD schedule 40 galvanized steel termination and corner posts (for gate posts, see Part 1.1 B), installed in lengths, quantities, and locations as shown on the drawings.

B. Gates

I. Install one (1) 14 ft opening heavy-duty industrial gates in chain link fencing enclosure in the locations shown on the drawings. Gates shall be suitable for electric operation and vehicular traffic.

2. Install one (1) 20 ft opening heavy-duty industrial double gate in chain link fencing enclosure in the location shown on the drawings. Gate shall be suitable for manual operation and vehicular traffic.

2.02 ELECTRICALLY OPERATED VEHICULAR GATE EQUIPMENT

A. Gate Operators shall **be Door King Model 6300, 230 V, 1 ph, 0.5 hp** or equal with one master and one slave unit, for double-swing gates. Operator shall be equipped with post mount kit.

B. Loop detectors shall be Door King electronic loop detectors designed for use with the microprocessor-based control board, one single-channel detector and one dual channel loop detector, or equal, for use with reversing, shadow, and free exit loops on a swing gate operated system.

C. The swing gate shall be able to automatically set its own open and close limit settings.

D. An adjustable timer shall be built into the control board to allow the gate to automatically close.

E. A tamper detect function shall start the motor to re-close the gate if the gate is forced open without an authorized command.

F. Master/Slave interconnect cable shall be Door King for connecting both high and low-voltage interconnections between the master and slave gate operators or equal.

G. Vehicular Gate Operators shall be design for Class-111, Industrial/Limited Access operation.

H. The gate operator shall be designed in such a way that if an obstruction is met during the opening or closing cycles, the gate operator will automatically reverse the gate. This reverse system shall be inherently designed into the operator so that if the external reverse devices fail or become inoperative, the operator will still sense the obstruction and reverse the gate.

I. The inherent reverse system in the gate operator shall consist of a primary system that will reverse the gate if an obstruction is sensed. Should the primary system fail or become inoperative, a secondary inherent system will sense the obstruction and reverse the gate.

J. The primary system shall sense a clutch slippage and reverse the gate. Should the clutch fail to slip, the secondary system will sense a stoppage and reverse the gate.

K. The gate operator shall stop and activate the internal alarm upon sensing an entrapment (two sequential activations of the inherent sensing system) and shall require activation of the reset switch prior to returning to normal operation, as required by UL 325 safety standard.

L. For enhanced safety, the operator shall upon sensing an entrapment, release pressure on the gate and assume a fail-safe condition to allow any entrapment the opportunity to free itself without the need of outside intervention.

M. The gate operator shall incorporate a "fail-safe" design that will allow manual operation of the gate from either the inside or the outside without the need of any hand cranks, keys or other mechanical devices, as the primary manual release device.

N. The manual release device shall be affixed to the operator and be capable of bring quickly operated in an entrapment situation.

1. The release must be an integral (non-removable) part of the operator.
2. A single non-repetitive movement shall cause an action that will allow the gate to be manually operated.
3. The manual release or manual operation of the gate shall not result in a risk of injury to persons if the operator is activated while the manual release is activated or being used.

O. Swing gate operator shall be 16" wide, 31 " long, 12" high with post mounting kit.

P. Loop detection shall be provided and plug into the main control board and prevent the fate from closing on vehicular traffic.

Q. Contact edge sensors shall be provided to reverse the gate on contact with any object.

2.03 ELECTRICAL OPERATED GATE KEYPAD

A. Furnish and install one (1) Door King Model 1506 100-Memory Illuminated Keypads or equal.

B. Keypad shall be installed on a gooseneck stand with 12" sweep at 42" high.

C. Keypad shall require 16-volt AC power, two form C dry contact relays, 30 V I amp maximum.

D. Capacity shall be 100 4-digit codes, six 5-digit codes.

E. Keypad shall be such that individual PINs can be added or deleted from the keypad and a "hold" code can be programmed to latch open the gate if needed for an extended period of time.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Shall be installed by qualified technicians who have been factory trained and certified.

B. Equipment shall be post mounted firmly secured, plumb and level.

C. Wiring shall be uniform and in accordance with national electric codes and manufacturer's instructions.

D. All splices shall be easily accessible junction boxes or on terminal boards. E. All cable runs in all junction boxes shall be tagged and identified.

E. Coordinate all work with other effected trades and contractors.

3.02 SYSTEM INITIALIZATION AND PROGRAMMING

A. System shall be turned on and adjustment made to meet requirements of specifications and onsite conditions. B. System shall function as specified.

3.03 SYSTEM TEST PROCEDURES

A. System shall be completely tested to assure that all components, and accessories are hooked-up and in working order.

B. System shall be pre-tested by contractor and certified to function in accordance with plans and specifications.

C. System shall be tested in presence of owner's representative.

3.04 OWNER INSTRUCTIONS

A. Contractor shall conduct up to four (4) hour s of instruction in use and operation of the system to designated owner representatives, within thirty (30) days of acceptance of installation.

B. Contractor shall conduct up to four (4) hours of technical training, in trouble shooting and service of the system, to designated owner representatives within thirty (30) days of acceptance of installation.

3.05 MANUALS AND DRAWINGS

A. Contractor shall provide owner with six (6) copies of standard factory prepared operation, installation and maintenance manuals. Manuals shall include typical wiring diagrams.

B. Contractor shall provide owner with six (6) copies of any risers, layouts, and special wiring diagrams showing any changes to standard drawings, if required on project.

3.06 MAINTENANCE

A. The manufacturer recommends periodic maintenance at three-month intervals as described in the installation and maintenance manual.

B. External reversing devices should be checked at least once a month.

END OF SECTION

INDEX TO

SECTION 32 92 00

TURF AND GRASSES

SECTION 32 92 00

TURF AND GRASSES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Contractor to use stablished sod on all graded areas behind the structures, pipeline rights–of–way, roadway shoulders, slopes and other disturbed areas not covered with gravel, crusher run, concrete, or asphalts (except for Phase II area). Phase II designated area can be seeded and fertilized.

B. Seed protection.

C. Maintaining seeded areas until final acceptance.

D. Irrigation system: Contractor shall provide a permanent irrigation system to water areas showing to be planted on the landscape sheets using plant reuse water. Submit design for approval. Use T010 or Rainbird Products.

1.02 IRRIGATION PIPING DESIGN WORK

contractor to submit to Engineer an irrigation design plan prepared by irrigation company. Design shall include piping size, spray head irrigation, valves, plans and specifications.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed in original containers showing analysis of seed mixture, percentage of pure seed, year of production, net weight, date of packaging, and location of packaging. Damaged packages are not acceptable. Store in cool, dry locations away from contaminants.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer. Damaged bags are not acceptable. Store in cool, dry locations away from contaminants.

C. Deliver sod on pallets.

D. All material shall be acceptable to Engineer prior to use.

1.04 PLANTING DATES

A. This specification provides for establishment of a permanent grass cover between the dates of March 1 and September 30. If finished earth grades are not completed in time to permit planting and establishment of permanent grass during the favorable season between dates specified above unless otherwise accepted, Contractor will be required to plant a temporary cover to protect new graded areas from erosion and to keep windborne dust to a minimum. The temporary cover shall be planted between October 1 and February 28 unless otherwise permitted.

PART 2 – PRODUCTS

A. Contractor shall submit source and species certification documents to Engineer and Owner's Representative for review prior to installation. Supply complete information on all analysis/test methodologies and results; laboratory certifications, manufacturer's specifications, and agency approvals to the Landscape Architect/Project Engineer prior to placement of soil mixtures. In addition, provide the Landscape Architect/Project Engineer with thoroughly mixed sample of soil mixes for acceptance prior to placement. Landscape Contractor shall make modifications and improvements to soil mixes deemed necessary by the soil analysis to meet requirements specified here in before, and to ensure proper growing medium for plant material.

2.01 SEED

A. All seed shall conform to State Laws and requirements and regulations of the State Department of Agriculture.

B. The varieties of seed, as specified in Section 2.2, shall be individually packaged or bagged, and tagged to show name of seed, net weight, origin, germination, lot number, and other information required by the State Department of Agriculture.

C. Engineer reserves the right to test, reject, or accept all seed before seeding.

2.02 SEEDING SCHEDULE

A.

SEED	RATE	PLANTING DATES
Bermuda	15–lbs/acre	March 1 – September 30
Brown top millet	10–lbs/acre	
Rye	40-lbs/acre	

2.03 FERTILIZER

A. Commercial fertilizer of accepted type, conforming to State fertilizer laws at the rate as recommended by soils test.

2.04 LIME

A. Agricultural grade, ground limestone at the rate as recommended by soils test.

2.05 SPRIG

A. Healthy living stems, stolons, or rhizomes and attached roots of locally adapted grass without adhering soil, including two to three nodes and from 4 to 6 inches long. Obtain from heavy, dense certified sod. Provide sprigs which have been grown under climatic conditions similar to those in the locality of project. Coordinate harvesting and planting operations to prevent exposure of sprigs to the sun for more than 30 minutes before covering and moistening. Sprigs showing signs of wilt, mold, containing weeds, or other detrimental material or are heat damaged will be rejected.

B. Varieties of sprig, as specified in section 2.6, shall be individually packaged or bagged, and tagged to show name of sprig, net weight, origin, and other information required by the State Department of Agriculture.

C. Sprigs shall be pure to variety specified and shall be free of other grass species, weeds or foreign matter.

D. Sprigs shall be harvested by digging (not collected above soil level), shredding sod, rototilling sod and raking, vericutting, or with a sprig harvester. Sprigs shall consist of mostly rhizomes and crowns with only a few green leaves.

2.06 SPRIGGING SCHEDULE

A.

SPRIG	RATE	PLANTING DATES
'Tifsport' Bermuda	1,000 bushels/acre (Maximum 12 week grow-in)	April 1 – August 31
Stabilize site with temporary grass seed		September 1 – March 31 (See section 2.2)

B. In areas where existing grass is to be matched, Contractor shall sprig at the rate and dates recommended by sprig distributor.

2.07 SOD

A. Sod shall be premium grade, densely rooted, good quality grass of the species and certified variety as shown on the plans, free from noxious weeds with no surface soil being visible. The sod shall be obtained from areas where the soil is reasonably fertile. Sod of specified species shall be grown from seed or sprig with not less than 95 percent germination, 85 percent pure seed, and not more than 0.5 percent weed seed. The sod shall be machine cut to a uniform soil thickness that shall contain practically all of the dense root system and not be less than 1–inch thick.

B. Before cutting, sod shall be mowed to a height of not less that 1–1/2-inches or more than 2-inches. Sod shall be cut in minimum uniform widths of 12-inches and lengths of 24 inches.

C. Sod shall be delivered to site in a fresh, moist condition with healthy green foliage. It shall be unloaded from delivery trucks on pallets or in rolls and placed in final position within 24 hours of delivery. Sod shall be protected from wind and sun and shall not be allowed to dry out before planting.

D. Sod shall be strong enough to support its own weight and retain its size and shape when suspended vertically from a firm grasp on the upper 10 percent of the section.

2.08 ACCESSORIES

A. Straw Mulch: Oat or wheat straw, reasonably free from weeds, foreign matter detrimental to plant life, and in dry condition.

B. Excelsior Mulch: Excelsior mulch shall consist of wood fibers cut from sound, green timber. The average length of fibers shall be 4 to 6 inches. Cut shall be made in such a manner as to provide maximum strength of fiber, but at a slight angle to natural grain of the wood to cause splintering of fibers when weathering in order to provide adherence to each other and to soil.

C. Wood cellulose fiber shall be made from wood chip particles manufactured particularly for discharging uniformly on the ground surface when dispersed by a hydraulic water sprayer. It shall remain in uniform suspension in water under agitation and blend with grass seed and fertilizer to form a homogenous slurry. Mulch fibers shall intertwine physically to form a strong moisture holding mat on the ground surface and allow rainfall to percolate into underlying soil. The mulch shall be heat processed to contain no germination or growth-inhibiting factors. It shall be dyed (non-toxic) an appropriate color to facilitate metering of material.

2.09 TOPSOIL

A. Topsoil shall be fertile, friable natural loam capable of sustaining vigorous plant growth. It shall be free of any admixture of subsoil, stones over 1-inch diameter, clods of hard earth, plants, roots, sticks or other extraneous material. It shall not be excessively acid or alkaline.

2.10 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer will review all products before they are ordered.

PART 3 – EXECUTION

3.01 PREPARATION

A. Areas to be seeded shall be made smooth and uniform and shall conform to the finished grade indicated on plans.

B. Remove all foreign materials, plants, roots, stones, and debris from surfaces to be seeded.

C. Grassing areas, if not loose, shall be loosened to a minimum depth of 3 inches before fertilizer, seed or sod is applied.

D. Amendments to soils shall be incorporated into loosened 3-inch top soil layer as recommended by soils tests.

E. Existing topsoil shall be stripped and stockpiled for future use in an area approved by the Owner. Contractor shall spread topsoil in all areas to have turf or grass. Contractor shall provide additional topsoil as needed at no additional cost.

F. Contractor shall provide Topsoil Analysis Tests performed by a State Agricultural Experiment Station, Soil and Water Conservation District, State University, or other qualified private testing laboratory, as acceptable to Landscape Architect/Engineer. Soils test shall identify existing pH and nutrient levels, as well as recommended adjustments based on the type of grass to be installed.

3.02 STAND OF GRASS

A. Before acceptance of seeding, sodding, or sprigging is performed for the establishment of permanent vegetation, Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed sufficiently to survive dry periods and winter weather and be capable of re-establishment in spring.

B. Before acceptance of seeding is performed for the establishment of temporary vegetation, Contractor will be required to produce a stand of grass sufficient to control erosion for a given area and length of time before the next phase of construction or establishment of permanent vegetation is to commence.

3.03 SEEDING AND SPRIGGING DATES

A. Seeding and sprigging shall be performed during periods and at rates specified in their respective schedules. Seeding and sprigging work may, at discretion of Contractor, be performed throughout the year using schedule prescribed for given period. Seeding and sprigging work shall not be conducted when the ground is frozen or excessively wet. Contractor will be required to produce a satisfactory stand of grass regardless of the period of year work is performed.

3.04 APPLYING LIME AND FERTILIZER

A. Following advance preparation and placing selected material for shoulders and slopes, lime and fertilizer, if called for based on soil tests, shall be spread uniformly over the designated areas, and shall be thoroughly mixed with the soil to a depth of approximately 2 inches. Fertilizer and lime shall be applied at the rate recommended by required soils test. Unless otherwise provided, lime will not be applied for temporary seeding. In all cases where practicable, acceptable mechanical spreaders shall be used for spreading fertilizer. On steep slopes subject to slides and inaccessible to power equipment, the slopes shall be adequately scarified. Fertilizer may be applied on steep slopes by hydraulic methods as a mixture of fertilizer and seed. When fertilizer is applied with combination seed and fertilizer drills, no further incorporation will be necessary. The fertilizer and seed shall be applied together when Wood Cellulose Fiber Mulch is used. Any stones larger than 2-1/2 inches in any dimension, larger clods, roots, or other debris brought to the surface shall be removed.

3.05 SEEDING

A. Seed shall be sown within 24 hours following application of fertilizer and lime and preparation of the seedbed as specified in Section 3.4. Seed shall be uniformly sown at rate specified by the use of acceptable mechanical seed drills. Rotary hand seeders, power sprayers or other satisfactory equipment may be used on steep slopes or on other areas inaccessible to seed drills.

B. Seeds shall be covered and lightly compacted by means of cultipacker or light roller if the drill does not perform this operation. On slopes inaccessible to compaction equipment, the seed shall be covered by dragging spiked chains, by light harrowing or by other satisfactory methods.

C. Apply water with fine spray immediately after each area has been sown.

D. Do not sow seed when ground is too dry, during windy periods or immediately following a rain.

E. If permitted by the special provisions, wood cellulose fiber mulch or excelsior fiber mulch may be used.

3.06 SEED PROTECTION (STRAW MULCH)

A. All seeded areas seeded with permanent grasses shall be uniformly mulched in a continuous blanket immediately following seeding and compacting operations, using at least 2 tons of straw per acre.

3.07 SEED PROTECTION (EXCELSIOR MULCH)

A. Seed shall be sown as specified in Section 3.05. Within 24 hours after covering of seed, excelsior mulch shall be uniformly applied at the rate of 2 tons per acre. The mulch may be applied hydraulically or by other acceptable methods. Should the mulch be placed in a dry condition, it shall be thoroughly wetted immediately after placing. Engineer may require light rolling of the mulch to form a tight mat.

3.08 SEED PROTECTION (WOOD CELLULOSE FIBER MULCH)

A. After the lime has been applied and ground prepared as specified in Section 3. 4, wood cellulose fiber mulch shall be applied at a rate of 1,500 pounds per acre in a mixture of seed and fertilizer. Hydraulic equipment shall be used for application of fertilizer, seed, and slurry of the prepared wood pulp. This equipment shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry of the specified amount of fiber, fertilizer, seed, and water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of slurry on various areas to be seeded. The slurry tank shall have a minimum capacity of 1,000 gallons.

Seed, fertilizer, wood pulp mulch, and water shall all be combined into the slurry tank for distribution of all ingredients in one operation by hydraulic seeding method specified herein. Materials shall be combined in a manner recommended by the manufacturer. The slurry mixture shall be regulated so amounts and rates of application shall result in a uniform application of all materials at rates not less than amount specified. Using the color of wood pulp as a guide, equipment operator shall spray prepared seedbed with a uniform visible coat. The slurry shall be applied in a sweeping motion, in an arched stream to fall like rain, allowing wood fibers to build upon each other until an even coat is achieved.

3.09 SPRIGGING

A. Sprigs shall be placed at the date and rates as shown in section 2.06. The sprigging method shall be by broadcast sprigging, hydroplanting or row planter. Sprigging procedure shall ensure even coverage.

B. Sprigs applied by broadcast over the site with a distributor or hydroseeder shall be planted at the rates listed in section 2.06. Cover broadcast sprigs with straw mulch immediately after broadcast and water in immediately (within 2 hours).

C. Sprigs installed by row planter creating a narrow furrow that covers 50 to 80% of the sprig with soil may use less sprig material. Rate shall be as recommended by sprig supplier to provide a solid stand of turf within the time required in Section 2.06. Water in immediately (within 1 hour).

3.10 SODDING

A. Sod shall be placed between March 1st and December 1st. However, if sod is to be placed during periods of temperatures over 90 degrees F., the Contractor shall take extra care for quick placement of sod with adequate, consistent watering necessary to ensure sod thrives as planted.

B. Sod shall be placed within 24 hours of cutting.

C. Place top elevation of sod 1/2 inch below adjoining paving or curbs.

D. All areas to be sodded shall be brought to the proper line grade or cross section as was existing prior to construction. Sod shall be placed so, upon completion, edges of sodded areas will be smooth and will conform to the proposed finished grade. Sod shall be laid smooth, edge to edge, with staggered joints. Sod shall be immediately pressed firmly into contact with the sod bed by tamping or rolling, to eliminate any air pockets. A true and even surface shall be provided, to insure knitting without displacement of the sod or deformation of the sodded areas surfaces. Do not stretch or overlap sod pieces. Following compaction, screened soil of good quality shall be used to fill all cracks. Excess soil shall be worked into the grass with rakes or other suitable equipment. On slopes steeper than 3 to 1, sod shall be fastened in place with suitable wood or metal pins to hold the sod in place. Any damage by erosion or other causes occurring after completion of grading operations shall be repaired, before commencing with the sodding operations.

E. Immediately before sodding, moisten topsoil with a fine spray to a minimum 1-inch depth. Sod shall not be laid on dry or powdery soil.

F. Sod shall be moist when laid and placed on moist ground. The sod shall be carefully placed by hand, beginning at the toe of slopes and working upwards. The length of strips shall be at right angles to flow of surface water. All joints shall be tightly butted and end joints shall be staggered at least 12 inches. Sod shall be immediately pressed firmly into the ground by tamping or rolling. Fill all joints between strips with fine screened soil. Sod on slopes shall be pegged with sod pegs to prevent movement.

G. Within two hours after sod has been placed, thoroughly water to a minimum depth of 4-inches. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove depressions and irregularities. Roll sodded areas with a roller not exceeding 150 lbs. per foot of roller width.

PART 4 – MAINTENANCE, WARRANTY AND ACCEPTANCE

4.01 MAINTENANCE

A. Maintain grassed surfaces until final acceptance.

B. Maintenance shall consist of providing protection against traffic, watering to ensure uniform seed germination and to keep surface of soil damp, and repairing any areas damaged as a result of construction operations or erosion. Maintenance shall also include, but is not limited to, watering, weeding, cultivating, removal of dead material, lawn mowing, fertilizing, and other necessary operations.

C. The Contractor shall maintain all proposed plantings until the date of substantial completion issued by the Owner.

4.02 WARRANTY

A. All grassed areas shall be guaranteed by Contractor to be alive and healthy during the warranty period as issued by the Owner. A final walk through with the Owner shall be conducted at end of warranty period to determine if any areas require replanting. At end of warranty period, sod shall show evidence of rooting to underlying soil and shall have no competitive weed growth from either the sod or from between sod joints.

B. Any grassed area which is dead or not showing satisfactory growth shall be replaced at Contractor's expense at the end of warranty period. All replacement shall be of original quality. Replacement required because of vandalism, excessive use, or other causes beyond the control of Contractor are not part of this contract.

4.03 ACCEPTANCE

A. Before acceptance of seeding performed for the establishment of permanent vegetation, Contractor will be required to produce a satisfactory stand of perennial grass whose root system shall be developed sufficiently to survive dry periods and winter weather and be capable of reestablishment in spring.

B. A minimum coverage of 90% density over 100% of the disturbed area is required for seeded areas before project acceptance. Sprig and sod areas shall have 95% coverage over 100% of the disturbed area prior project acceptance.

END OF SECTION

INDEX TO

SECTION 33 05 01.03

DUCTILE IRON PIPE

SECTION 33 05 01.03

DUCTILE IRON PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies ductile iron pipe, ductile fittings and gaskets.

B. DEFINITION:

Where cast iron pipe is specified, the term and symbol shall mean ductile iron pipe.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI A21.14	Ductile-Iron Fittings 3 In. Through 24 In., for Gas
ANSI A21.52	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand Lined Molds for Gas
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A716	Ductile-Iron Culvert Pipe
AWWA C104 (ANSI A21.4)	Cement-Mortar Lining for Ductile- Iron and Gray-Iron Pipe and Fittings for Water
ANSI/AWWA C105/A21.5	Polyethylene Encasement for Ductile-Iron Pipe Systems

Reference	Title
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In., for Water and Other Liquids
AWWA C111 (ANSI A21.11)	Rubber-Gasket Joints for Ductile- Iron and Gray-Iron Pressure Pipe and Fittings
AWWA C115 (ANSI A21.15)	Flanged Ductile-Iron and Gray-Iron Pipe with Threaded Flanges
AWWA C150 (ANSI A21.50)	Thickness Design of Ductile-Iron Pipe
AWWA C151 (ANSI A21.51)	Ductile-Iron Pipe, Centrifugally Cast, in Metal Molds or Sand-Lined Molds, for Water or Other Liquids
AWWA C153 (ANSI A21.53)	Ductile-Iron Compact Fittings, 3 In. Through 12 In. for Water and Other Liquids
AWWA C600	Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Type Joints

PART 2 - PRODUCTS

2.01 GENERAL

Pipe design, materials and manufacture shall comply with the following documents:

Item	Document
Thickness design	AWWA C150
Manufacturing requirements	
Water or other liquid	AWWA C151
Gas	ANSI A21.52
Gravity service pipe	ASTM A716
Joints	
Rubber gasket	AWWA C111
Threaded flange	AWWA C115
Fittings	
Water or other liquid	AWWA C110/AWWA C153
Gas	ANSI A21.14
Cement mortar lining	AWWA C104

2.02 PIPE

Ductile iron pipe shall be in accordance with ANSI A21.50/AWWA C150 and conform to the requirements of A21.51/AWWA C151, latest standards. Push-on, and restrained joint pipe shall have a minimum rated working pressure of 150 psi. All buried pipe shall have the minimum pressure class listed below:

Pipe Sizes (inches)	Pressure Class (psi)
4-12	350
14-20	250
24	200
30-64	150

2.03 GASKETS

Unless otherwise specified, gaskets shall be standard styrene butadiene copolymer (SBR) with a max service temperature in water/sewer and air of 150 degrees F. and shall be suitable for freshwater, saltwater and sanitary sewer application. Mechanical joint rubber gasket configuration and materials shall comply with AWWA C111 and shall be in accordance with the applicable joint type and pressure rating of the piping system. Gaskets shall, in addition, comply with AWWA C111 for push-on and mechanical joints and with AWWA C606 for grooved end joints. If organic solvents or petroleum products are encountered during the course of the work, alternate gasket materials or joint treatment may be required by the Engineer.

2.04 FITTINGS

Unless otherwise specified, fittings shall conform to AWWA C110. Ends shall be flanged, restrained mechanical joint, restrained push-on, or grooved to suit the conditions specified. The AWWA C153 compact ductile iron fittings in sizes 3 through 12 inches are an acceptable substitute for standard fittings unless otherwise specified. Long-radius elbows shall be provided where specified. Grooved end fittings shall comply with paragraph 40 27 05-1.02 B.

2.05 JOINTS

A. UNRESTRAINED JOINTS:

1. PUSH-ON JOINTS: Unrestrained joints, where specified, shall be the rubber ring compression, push-on type joint suitable for buried service. Unrestrained joints shall be the Fastite Joint as manufactured by American Cast Iron Pipe Company, the Tyton Joint as manufactured by U.S. Pipe, or equal. This joint is not permitted on fittings or specials, unless otherwise specified. Unless otherwise specified, joints shall have an allowable deflection up to 5 degrees at specified pressures. Joint assembly and field cut joints shall be made in strict conformance with AWWA C600 and manufacturer's recommendations.

2. MECHANICAL JOINTS: Where specified, mechanical joints for above or below ground service shall meet the requirements of ANSI/AWWA

A21.10/C110 and ANSI/AWWA A21.11/C111. Gaskets and bolts and nuts shall comply with paragraphs 33 05 01.03-2.03 and 2.05 D, respectively.

B. RESTRAINED JOINTS:

1. GENERAL: Unless otherwise specified, restrained joints are required for all exposed and buried piping. Unless otherwise specified, restrained joints shall be flanged or grooved end for exposed service and restrained push-on for buried service.

2. PUSH-ON JOINTS: Restrained push-on joints shall be as specified in paragraph 33 05 01.03-2.05 A.1., modified for restraint. Joints shall be the Flex-Ring or Lok-Ring Joint as manufactured by American Cast Iron Pipe Company, TR Flex Joint as manufactured by US Pipe, or equal. Restrained joints shall be capable of being deflected after full assembly. Joint assembly shall be in strict conformance with AWWA C600 and manufacturer's recommendations. No field cuts of restrained pipe are permitted without prior approval of the Construction Manager.

3. FLANGE ASSEMBLIES: Unless otherwise specified, flanges shall be ductile iron and shall be threaded-on flanges conforming to ANSI/AWWA A21.15/C115 or cast-on flanges conforming to ANSI/AWWA A21.10/C110. Flanges shall be adequate for 250 psi working pressure. Bolt circle and bolt holes shall match those of ANSI B16.1, Class 125 flanges and ANSI B16.5, Class 150 flanges. Where specified, flanges shall be threaded-on or cast-on flanges conforming to ANSI B16.1, Class 250.

   Unless otherwise specified, bolts and nuts for flange assemblies shall conform with paragraph 40 27 05.04-2.01 C. Gaskets shall be as specified in paragraph 40 27 05.04-2.01 B.

4. MECHANICAL JOINTS: Where specified, restrained mechanical joints shall be the positive restraint type. Mechanical joints with retainer glands are not acceptable.

   Locked mechanical hydrant tees, bends and adapters are an acceptable substitute for anchoring fire hydrants and valves to the pipe main.

5. Restrained Joints: Shall be EBBA Megalug or approved equal.

C. BALL AND SOCKET FLEXIBLE JOINT PIPE:

Ball and socket flexible joint pipe shall be the boltless type and shall allow a maximum joint deflection of 15 degrees. Each joint shall be provided with a retainer lock to prevent rotation after assembly. Joints shall be the Flex-Lok Joint as manufactured by American Cast Iron Pipe Company, USIflex as manufactured by U.S. Pipe, or equal.

D. BOLTS AND NUTS:

Stainless steel (SS316) bolts and nuts for use with ductile iron joints shall be used. Bolts and nuts shall be lubricated with an Owner-approved anti-seize compound.

2.06 PIPE COATING

Unless otherwise specified, pipe and fittings shall be coated with asphaltic material (min. 1mil) as specified in AWWA C151.

2.07 PIPE LINING

A. WATER AND REUSE WATER LININGS

Cement mortar lining is advisable for lines handling pH levels ranging from 6-10. Other pH levels shall have suitable lining. Ductile iron pipe, specials, and fittings shall be lined with cement mortar lining in accordance with AWWA C104.

B. SEWAGE SERVICE LININGS

Ductile iron pipe and fittings shall receive an interior lining of 40-mil (min.) nominal Protecto 401 epoxy, or equal.

C. SCUM & GRIT LINING

Glass lined.

2.08 PRODUCT DATA

The following information shall be provided:

1. Shop drawings.

2. Alignment drawings.

3. Certifications specified in the following documents:

ANSI A21.14, paragraph 14-4.2
ANSI A21.52, paragraph 52-4.2
ASTM A716, paragraph 4.2
AWWA C110, paragraph 10-5.3
AWWA C111, paragraph 11-7.1
AWWA C115, paragraph 15-4.2
AWWA C151, paragraph 51-5.2
AWWA C153, paragraph 53-6.3
AWWA C606, paragraph 4.1.1.1

2.09 QUALITY ASSURANCE

Contractor shall submit evidence that the ductile iron pipe and fitting manufacturer has a minimum of ten years' experience in material production of diameters noted on the plans and specifications. Ductile iron pipe is preferred to be domestically manufactured in the United States. All pipe material suppliers shall be ISO registered or provide the services of an independent inspection agency. Prior to the start of manufacturing, any manufacturer not meeting the ISO registration requirements shall submit to the Owner and Owner's Engineer the names of an independent inspection agency for approval.

2.10 PRODUCT DELIVERY, STORAGE & HANDLING

Material shall be unloaded in a manner that will avoid damage and shall be stored where it will be protected and will not be hazardous to traffic. It shall be handled according to manufacturer's recommendations. A fork inserted inside the pipe is not allowed. The Contractor shall repair or replace any damage caused by the storage or handling. Material shall be examined before installation and neither damaged nor deteriorated material shall be used in the work. Owner and Engineer have the right to reject defective or damaged material.
Delivery, storage, and handling of ductile-iron pipe and fittings shall follow the recommendations of AWWA C600 and as specified herein:

a. Handling of pipe shall be performed with lifts, cranes, or other suitable equipment and devices. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the pipe, linings, and coatings. The pipes shall not be dropped or dragged.
b. During transport, the pipe shall be supported and secured against movement using padded devices in such a manner to prevent damage.
c. Stored pipe shall be protected from damage and kept free from dirt and foreign materials by closing the ends of the pipe. Other pipeline materials shall be protected by appropriate packaging or wrapping. Gaskets shall be stored in a cool location out of direct sunlight. Bolts, nuts, and washers shall be handled and stored in a dry location in a manner that will ensure proper use with respect to types and sizes.
d. Pipe laid out for installation shall be placed on earth berms or timber cradles adjacent to the trench in the numerical order of installation.
e. Maintain plastic end caps on all pipe and fittings in good condition until the pipe is ready to be installed in the trench. Periodically open the plastic end caps and spray clean potable water inside the pipe for moisture control.
f. Under no circumstances shall ropes or other handling devices be attached through the interior of fittings

2.11 RECYCLED/EFFLUENT WATER IDENTIFICATION

Ductile-iron pipe and fittings for recycled or effluent water shall be identified with purple-colored coating, sleeves, identification labels or signs.

PART 3 - EXECUTION

3.01 INSTALLATION

A. GENERAL:

Piping runs specified on the drawings shall be followed as closely as possible. Proposed deviations shall be submitted.

Pipe shall be installed in accordance with AWWA C600.

Connections to existing structures and manholes shall be made so that the finished work will conform as nearly as practicable to the requirements specified for the new manholes, including necessary concrete work, cutting and shaping. Concrete mortar shaping within any structure and manhole shall be as specified.

B. INSULATING SECTIONS:

Where a metallic nonferrous pipe or appurtenance is connected to ferrous pipe or appurtenance, an insulating section shall be provided as specified in paragraph 40 27 05.04-3.05.

C. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted.

3.02 ACCEPTANCE TESTING

Hydrostatic pressure tests shall be conducted in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 27 05.

The Contractor shall conduct the tests in the presence of the Engineer or Owner.

END OF SECTION

INDEX TO

SECTION 33 05 01.09

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

SECTION 33 05 01.09

POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (A WW A):

   a. C110, Ductile-Iron and Gray-Iron Fittings for Water.
   b. C116, Protective Fusion Bonded Epoxy Coating for the Interior and Exterior Surfaces of Ductile Iron and Grey iron Fittings for Water Supply Service.
   c. C153, Ductile-Iron Compact Fittings, for Water Service.
   d. C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
   e. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Distribution.
   f. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
   g. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inches through 12 Inches (100 mm through 300 mm), for Water Distribution.

2. ASTM International (ASTM):

   a. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   b. D2241, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
   c. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   d. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
   e. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
   f. D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

3. NSF International (NSF).

1.02 SUBMITTALS

A. Action Submittals: Drawings showing pipe diameter, pipe class, and fitting details.

B. Informational Submittals:
   1. Manufacturer's Certificate of Compliance, in accordance with Section 01 0001, General Requirements.
   2. Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:

      a. Testing dates.
      b. Piping systems and section(s) to be tested.
      c. Method of isolation.
      d. Method of conveying water from source to system being tested.
      e. Calculation of maximum allowable leakage for piping section(s) to be tested.

   3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
   4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Pipe:

   1. PVC, conforming to requirements of AWWA C900 for diameters 12 inches and smaller or AWWA C905 for diameters larger than 12 inches.
   2. DR shall be 18 for C900 pipe and 25 for C905 pipe.
   3. Pipe to be used for potable water conveyance shall be manufactured from National Sanitation Foundation (NSF) approved compounds.

B. Joints:

   1. Rubber gasketed.
   2. Conform to AWWA C900 or AWWA C905.

C. Fittings: Conforming to AWWA C153 or AWWA C110. Fusion bonded epoxy coating (interior and exterior) ductile iron or cement-lined ductile iron as specified on the Pipe Schedule included as a supplement to Section 40 27 00, Process Piping-General.

D. Service Saddles:

1. Double strap type with minimum strap width of 2 inches.
2. Straps shall be Type 304 stainless steel. Saddles shall be Romac 202NS nylon coated saddles or approved equal.
3. Minimum Pressure Rating: 150 psi.

E. Restrained Joints:

Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push-on type joints equivalent to "Lok-Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure of 250 psi for ductile iron pipe and 100 psi with a minimum safety factor of 2:1 for PVC pipe. The joints shall be in accordance with the applicable portions of AWWA C-111. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

PART 3 – EXECUTION

3.01 INSTALLATION

A. In accordance with A WW A C605.

B. Solvent cement used for joints as recommended by pipe manufacturer.

C. Joints:

1. Rubber Gasketed: In accordance with manufacturer's written instructions.
2. Solvent Cemented: In accordance with ASTM D2855.
3. Restrained Joint Systems: In accordance with manufacturer's written instructions.

D. Pipe Bending for Horizontal or Vertical Curves:

1. Radius of curves shall not exceed 75 percent of manufacturer's recommended values.
2. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

E. Maximum Joint Deflection: 75 percent of manufacturer's recommended values.

3.02 INSPECTION AND HYDROSTATIC TESTING

A. General: In accordance with Section 40 80 01, Process Piping Leakage Testing.

END OF SECTION

INDEX TO

SECTION 33 05 01.10 – HIGH DENSITY POLYETHYENE (HDPE) PLASTIC PIPE

SECTION 33 05 01.10

HIGH DENSITY POLYETHYLENE (HDPE) PLASTIC PIPE

PART 1 – GENERAL

1.1 WORK INCLUDED

The work under this section covers high–density polyethylene (HDPE) pipe for sanitary sewer force mains and or water mains installed as a part of the horizontal directional drill process. The work includes the installation and testing of all polyethylene pipe and fittings for the main as shown on the Drawings. Provide all labor, materials, equipment and services indicated on the Drawings, as specified herein and as reasonably necessary or incidental to complete the job.

1.2 QUALITY ASSURANCE

A Georgia Registered Professional Engineer, other than Thomas & Hutton Engineering Co., shall design the final steel casing size (if applicable) and thickness and HDPE pipe wall thickness and shall submit the stamped design calculations to the Owner (assuming the area between the steel casing and the HDPE pipe contains water).

1.3 REFERENCED STANDARDS

Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these Specifications shall in no way invalidate the minimum requirements of the referenced standards.

ASTM D2321	Standard Practice for Underground Installation of Flexible Thermoplastic Pipe for Sewers and Other Gravity–Flow Applications
ASTM D3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (SDR–PR) Based on Outside Diameter.
ASTM D3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
AWWA C906	Standard Specification for Polyethylene (PE) Pressure Pipe and Fittings 4" through 63" for Water Distribution and Transmission

1.4 ACCEPTANCE OF PIPE

Acceptance of pipe will be based on design, material tests, and examination of the complete product. Quality of all materials used in the pipe, process of manufacture, and finished pipe shall be subject to examination by Engineer. Examination may be made at place of manufacture, or on job site after delivery, or at both places and pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at place of manufacture. All pipe which is rejected must be immediately removed from project site by the Contractor.

1.5 SUBMITTALS

A. Manufacturer's Certificate Pipe and Fittings: For information only, submit two copies of manufacturer's certificate indicating pipe and fittings have been examined and tested at the place of manufacture and meet requirements of referenced Standards and these Specifications.

B. Submit two copies of the Registered Professional Engineer's Design Calculations required by Paragraph 1.2 of this Section.

1.6 REQUIREMENTS OF REGULATORY AGENCIES

The HDPE pipe shall meet requirements and specifications of Georgia DOT including testing and disinfection as applicable.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

Material shall be unloaded in a manner avoiding damage and shall be stored where it will be protected and will not be hazardous to traffic. Contractor shall repair any damage caused by the storage. Material shall be examined before installation and neither damaged nor deteriorated material shall be used in the work. Owner and Engineer have the right to reject defective or damaged material.

1.8 SEQUENCING AND SCHEDULING

Contractor shall arrange work so sections of mains between valves are tested, sterilized, pavement replaced, and the section placed in service as soon as reasonable after it is placed. Owner reserves the right to dictate sequence of construction.

1.9 ALTERNATIVES

The intention of these specifications is to produce best system for Owner. If Contractor suggests alternative material, equipment or procedures will improve results at no additional cost, the Engineer and Owner will examine suggestion, and if it is accepted, it may be used. The basis upon which acceptance of an alternative will be given is its value to Owner, and not for convenience of Contractor.

1.10 GUARANTEE

Contractor shall guarantee the quality of materials, equipment, and workmanship for a period of 18 months after final project acceptance. Defects discovered during this period shall be repaired by Contractor at no cost to the Owner. The Contractor shall provide an 18–month guarantee.

1.11 EXISTING UTILITIES

All known utility facilities are shown schematically on plans and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities not shown on plans will not relieve the Contractor of responsibility under this requirement. "Existing Utilities Facilities" means any utility existing on the project in its original, relocated, or newly installed position. Contractor will be held responsible for cost of repairs to damaged underground facilities – even when such facilities are not shown on the plans. Contractor shall contact all utility companies prior to beginning work and request an accurate field location of their respective utility lines.

1.12 CONNECT NEW MAIN TO EXISTING SYSTEM

Contractor shall furnish necessary pipe and perform all excavation, dewatering, shoring, backfilling, etc., necessary to make the connection of a new main to existing system to be or already installed by others. Contractor shall contact the utility a minimum of 72 hours in advance of construction. Contractor shall be responsible for coordinating construction with the utility.

1.13 DAMAGE TO EXISTING SYSTEM

Damage to any part of existing system by Contractor or Subcontractors, which is repaired by Utility Owner's forces, or an acceptable contractor shall be charged to the Contractor on basis of time and material, plus an overhead and administration charge using Commission's multiplier, or plus 30% for overhead and administration for an acceptable contractor.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Polyethylene Pipe:

1. Provide high-density polyethylene pipe and fittings to comply with ASTM D3350. Pipe shall also meet the dimensions and tolerances as specified in ASTM F-714. Pipe shall be equivalent to Driscopipe 1000 as manufactured by Phillips Driscopipe Co., Inc., Plexco PE 3408 by Chevron Plexco, Inc. or by CSR Polypipe.

2. The required pipe SDR shall be determined by a Georgia Professional Engineer to meet operational and load conditions encountered after and during construction. Pipe diameter shall be **16" inside diameter.** The minimum **SDR shall be 17** for all sizes (ASTM F-714).

B. Pipe Joints: Pipe sections shall be permanently connected by thermal butt fusion in accordance with manufacturer's procedures using equipment specified by the pipe manufacturer. Mechanical jointing shall be accomplished with the use of flange adapters and stub ends complying with ASTM D3261 and in accordance with manufacturer's instructions for mechanical joining.

C. Fittings: Unless otherwise specified or indicated on the Drawings, all polyethylene fittings shall conform to ASTM D3261.

PART 3 – EXECUTION

3.1 GENERAL

Examine areas and conditions under which pipe is to be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.2 PIPE PACKAGING, HANDLING, STORAGE

A. The manufacturer shall package pipe in a manner designed to deliver it to the project neatly, intact, and without physical damage. The transportation carrier shall use appropriate method and intermittent checks to insure pipe is properly supported, stacked, restrained, and pipe interior protected from airborne contamination during transport, so pipe is not nicked, gouged, or physically damaged.

B. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If pipe must be stacked for storage, such stacking shall be done in accordance with the manufacturer's recommendations. Handling of pipe shall take place in such a manner it is not damaged by dragging over sharp objects or cut by chokers of lifting equipment.

C. Sections of pressure pipe having been discovered with cuts or gouges in excess of 10% of the pipe wall thickness shall be cut out and removed. The undamaged portions of pipe shall be rejoined using a heat fusion joining method.

D. Fused segments of pipe shall be handled to avoid damage to the pipe. When lifting fused sections of pipe, chains or cable type chokers must be avoided. Nylon slings are preferred. Spreader bars are recommended when lifting long fused sections. Care must be exercised to avoid cutting or gouging the pipe.

3.3 PIPE INSTALLATION

Install pipe in accordance with the manufacturer's recommendations. Adhere to Rules, Regulations, and Requirements of OSHA, Occupational Safety, and Health Act.

A. Trench Construction: The trench and trench bottom shall be constructed in accordance with ASTM D2321.

B. Embedment Material: Shall be Class I, Class II, or Class III materials as defined by ASTM D2321. The use of Class IV and Class V materials for embedment is not allowed. Class I crushed stone and Class II well-graded dense aggregates are preferred and shall have an installed density of at least 85% Standard Proctor Density through compaction or consolidation.

C. Bedding: Pipe bedding shall be performed in accordance with ASTM D2321. Compaction rates shall be as specified in ASTM D2321. Deviation from specified compaction rates shall only be allowed when accepted by the Engineer.

D. Haunching and Initial Backfill: Shall be as specified in ASTM D2321 using Class I, Class II, or Class III materials. In cases where a compaction rate of 95% Standard Proctor Density is not attainable, Engineer may increase the SDR of pipe to provide adequate stiffness.

E. Joint Fusion:

1. Joining sections of pipe and fittings shall be in continuous lengths by the heat fusion method and shall be performed in strict accordance with manufacturer's recommendations. The heat fusion equipment used in joining procedures should be capable of meeting all conditions recommended by pipe manufacturer, including, but not limited to, temperature requirements of 400°F, alignment, and 75 psi interfacial fusion pressure.

2. Heat fusion joining shall be 100% efficient offering a joint weld strength equal to or greater than the tensile strength of pipe. Socket fusion shall not be used. Flanges, unions, grooved–couplers, transition fittings and some mechanical couplers may be used to mechanically connect HDPE pipe without butt fusion. Refer to the manufacturer's recommendations. Both installers and joint examiners shall be trained by the manufacturer or its authorized representative. Fusion of unlike SDRs is not permitted. Transition from different SDRs using mechanical couplings or a transition nipple Polyethylene pipe shall be connected to systems or other material fittings using flanged connections or mechanical compression coupling for use with polyethylene pipe. Mechanical couplings shall be installed according to manufacturer's recommendations.

F. Special Conditions: ASTM–D2321–Section 11.2, Minimum Cover for Load Application, Section 11.3, Use of Compaction Equipment, and Section 11.4, Removal of Trench Protection shall apply unless directed otherwise by the Engineer.

3.4 HYDROSTATIC AND LEAKAGE TESTS

A. Hydrostatic and leakage tests of pressure lines shall be made by Contractor under the direction of Engineer.

B. High density polyethylene pipe shall be tested using hydrostatic procedures. The preferred testing medium is clean water, but other liquids may be used. The test section should be completely filled with liquid, taking care to bleed off any trapped air. While the test section is filling, venting at high points may be necessary to purge air pockets. The test pressure shall be 1–1/2 times the system design operating pressure.

C. The test procedure consists of initial expansion and test phases. For the initial expansion phase, makeup water is added as required to maintain the test pressure for three hours. For the test phase, the test pressure is reduced by 10 psi. If the pressure remains steady (within 5% of the target value) for an hour, no leakage is indicated. The total test time including initial pressurization, initial expansion, and time at test pressure, must not exceed eight hours. **If the test is not completed due to leakage, equipment failure, etc., depressurize the test**

section, and then allow it to "relax" for at least eight hours before bringing the test section up to test pressure again.

D. Should any test of the pipe laid disclose leakage, Contractor shall, at its own expense, locate and repair defective joints.

E. Contractor is responsible for notifying the Engineer 48 hours (minimum) prior to applying pressure for testing. Pressure test will be witnessed by the Engineer, Project Representative, and utility owner.

F. Potable water is available at a cost to the Contractor in accordance with current utility company rate structure. The cost of transporting water to construction site is an expense of Contractor.

3.5 DISINFECTION

A. After hydrostatic and leakage tests are satisfactorily completed, the HDPE carrier pipe shall be disinfected in accordance with AWWA C 651 and Regulations of Georgia EPD.

All new mains and repaired portions of, or existing mains shall be thoroughly flushed at a flow velocity greater than 2.5 feet per second then chlorinated with not less than fifty parts per million (50 ppm) of available chlorine. Chlorine gas or seventy percent high–test calcium hypochlorite can be used. Water from the existing distribution system or other source of supply should be controlled to flow slowly into newly laid pipeline during application of chlorine. The solution shall be retained in pipeline for not less than 24 hours and a chlorine residual of 25 ppm shall be available at this time. Then system shall be flushed with potable water and the sampling program started.

B. A minimum of two bacteriological samples shall be taken at least 24 hours apart after disinfection and tested by a State accepted lab and shall indicate the water line to be absent of total coliform bacteria. The number of sampling sites depends on the amount of new lines; however, all dead lines must be sampled. Results shall be submitted to Engineer by the Contractor. Results shall indicate coliform growth, non–coliform growth (NCG) and chlorine residual at the time of sampling. Results shall indicate sample date, location, and time, and shall be performed less than 30 days prior to the Engineer submitting for final permit to operate. All samples must be analyzed by a state certified laboratory.

END OF SECTION

INDEX TO

SECTION 33 05 01.12

GRAVITY SEWER PIPE AND FITTINGS

SECTION 33 05 01.12

GRAVITY SEWER PIPE AND FITTINGS

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):

   a. C105, Polyethylene Encasement for Ductile Iron Pipe Systems.
   b. C110, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm through 1200 mm), for Water.
   c. C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe -4 in. (100 mm) and Larger -Shop Applied.
   e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
   f. C302, Reinforced Concrete Pressure Pipe, Noncylinder Type.
   g. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in. (100 mm through 300 mm), for Water Distribution.

2. ASTM International (ASTM):

   a. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   b. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C151, Ductile-Iron Pipe, Centrifugally Cast, for Water.
   f. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   g. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
   h. C443, Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   i. C596, Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   j. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   k. D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   l. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
   m. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

n. D2241, Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
o. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
p. D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
q. D3212, Standard Specification for Joints For Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
r. E329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
s. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
t. F679, Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

1.02 DEFINITIONS

A. SDR: Standard Dimension Ratio.

1.03 SUBMITTALS

A. Action Submittals: Information on gasket polymer properties.

B. Informational Submittals:

1. Certificates:

a. Manufacturer's Certificate of Compliance, in accordance with Section 01 0001, General Requirements, that products furnished meet requirements of this section.
b. Certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with ASTM F477 for PVC pipe.

2. Manufacturer's Written In-Plant Quality Control Program: Quality control procedures and materials testing to be used throughout manufacturing process. Submit prior to manufacture of any pipe for this Project.
3. Test or historical performance data to verify that joint design meets requirements of these specifications.
4. Provide pipe test results with delivery of pipe. Do not deliver pipe not meeting test requirements to Project Site.
5. Manufacturer's written recommendations for pipe handling and installation.
6. PVC pipe deflection test results.

PART 2 – PRODUCTS

2.01 POLYVINYL CHLORIDE PIPE (PVC)

A. 15-Inch Diameter and Smaller:

1. In accordance with ASTM D3034.
2. Joints: Integral bell and spigot, in accordance with ASTM D3212.
3. Minimum SDR: 26.
4. Cell Classification: 12454-B or 12454-C, as defined by ASTM D1784.
5. Fittings: SDR 35 minimum wall thickness.
6. Gaskets: Factory fabricated rubber compression type with solid cross section in accordance with ASTM F477. Lubricant for joining pipe as approved by pipe manufacturer.

2.02 FLEXIBLE COMPRESSION COLLAR

A. Mechanical joint coupling with No. 305 stainless steel bands.

B. Manufacturers:

1. Calder, Inc., Bellflower, CA.
2. Femco Inc., Davison, MI.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Notify Engineer immediately of manufacturing imperfections or damage caused by improper handling.

B. Verify size, pipe condition, and pipe class prior to installation of pipe.

3.02 PREPARATION

A. Pipe Distribution: Do not distribute more than 1 week's supply of materials in advance of laying, unless otherwise approved by Engineer.

B. Inspect pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are being used.

C. Remove foreign matter and dirt from inside of pipe and fittings and keep clean during and after laying. Wash ends of section clean with wet brush prior to joining sections of pipe.

3.03 INSTALLATION

A. General:

1. Install pipe sections in accordance with manufacturer's recommendations.
2. Provide and use proper implements, tools, and facilities for safe and proper prosecution of Work.
3. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings. Do not drop or dump pipe into trenches.

B. Line and Grade:

1. Establish line and grade for pipe by use of lasers.
2. Measure for grade at pipe invert, not at top of pipe.
3. Do not deviate from line or grade, as shown on Drawings, more than 1/2 inch, provided that such variation does not result in a level or reverse sloping invert.

C. Laying and Jointing:

1. Use gasket lubricant as recommended by gasket manufacturer.
2. Lay pipe upgrade with bell ends pointing in direction of laying.
3. When field cutting, or machining pipe is necessary, use only tools and methods recommended by pipe manufacturer and approved by Engineer.
4. After section of pipe has been placed in its approximate position for jointing, clean end of pipe to be joined, inside of joint, and rubber ring immediately before joining pipe.
5. Assemble joint in accordance with recommendations of manufacturer.
6. Apply sufficient pressure in making joint to assure that joint is "home" as defined in standard installation instructions provided by pipe manufacturer. Inside joint space shall not exceed 50 percent of pipe manufacturer's recommended maximum allowance.
7. Place pipe to specified line and grade to form smooth flow line.
8. Ensure that bottom of pipe is in contact with bottom of trench for full length of each section.
9. Check for alignment and grade after joint has been made.
10. Place sufficient pipe bedding material to secure pipe from movement before next joint is installed.
11. When pipe is laid within movable trench shield, take precautions to prevent pipe joints from pulling apart when moving shield ahead.

    a. When laying operations are not in progress, and at close of day's work close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints.
    b. Take precautions to prevent "uplift" or floating of line prior to completion of backfill operation.

c. Connections between one pipe material and another shall be by means of flexible compression collar, installed in accordance with the manufacture's recommendations, or concrete closure collar.

D. Connection to Structure or Manhole:

1. Locate standard pipe joint within 1.5 feet of outside face of structure for pipe 18 inches and smaller and within one pipe diameter for pipe 21 inches and larger.
2. Plug or close off pipe stubbed with watertight plug.
3. Connect PVC pipe to manhole with pipe to manhole connector in accordance with manufacturer's recommendations.

3.04 CLEANING

A. Clean each section of completed sewer pipeline prior to testing.

B. Place screen or dam in downstream manhole of section being cleaned to catch debris.

C. Remove material from each manhole section before cleaning the next section downstream.

D. Method: High velocity hydro-cleaning equipment.

E. Cleaning water may not be discharged into existing sewer system after screening and removal of debris.

3.05 GASKET FIELD SPLICE TESTS

A. Perform field splice test on 20 percent of each lot of delivered gaskets, in accordance with ASTM C361 in presence of Engineer.

B. Furnish feeler gauges of proper size, type, and shape to verify proper placement of gasket.

C. Test section of gasket shall be at point where ends of gasket are joined together.

D. If gasket joints separate during test, entire lot will be rejected and shall immediately be removed from Site.

3.06 HYDROSTATIC AND PNEUMATIC TESTS

A. General: In accordance with 408001, Process Piping Leakage Testing.
B. All gravity sewer lines and storm lines shall be televised.

END OF SECTION

INDEX TO

SECTION 33 05 23.13 – HORIZONTAL DIRECTION DRILLING (HDD)

PART 1 – GENERAL

PART 2 – PRODUCTS

PART 3 – EXECUTION

SECTION 33 05 23.13

HORIZONTAL DIRECTIONAL DRILLING (HDD)

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Force Main

B. Water Main (Where Applicable)

1.2 OMITTED

1.3 REFERENCES

A. ASTM and ANSI Standards

B. "Ten States Standards" where applicable

C. AWWA Specifications where applicable

D. AREA Manual for Railway Engineering, Part 5 Pipelines

1.4 OPTIONS

A. It is the intent of these specifications to define the acceptable methods and materials for force main pipes by horizontal directional drilling method and the requirements for high density polyethylene (HDPE) pipe. If the Contractor suggests that alternate material, equipment or procedures will improve the results at no additional cost, the Engineer and the Owner will examine the suggestion and if it is accepted, it may be used. The basis upon which acceptance of an alternate will be given is its value to the Owner, and not for the convenience of the Contractor.

B. The specifications describe several materials. Where manufacturers and models of equipment are named in the specifications, it is intended that these are to describe the quality and function required. The Contractor may use equivalent equipment or materials of other manufacturers provided they are reviewed and accepted by the Engineer and the Owner as meeting the specifications.

C. <u>The Contractor will furnish the Engineer and the Owner a description of all materials before ordering. The Engineer will review the Contractor's submittals and provide, in writing, an acceptance or rejection of material</u>. However, an acceptance of any material by the Engineer does not relieve the Contractor of this responsibility to meet the requirements of the construction plans or these specifications.

1.5 QUALIFICATIONS

Directional drilling and pipe installation shall be completed only by an experienced Contractor specializing in directional drilling and whose key personnel have at least 5 years experience in this field. Furthermore, the Contractor shall have installed directionally drilled pipe at least as large as 16 inches in diameter, have experience in sedimentary drilling, and have performed crossings at least 1,000 feet in length.

1.6 QUALITY ASSURANCE

A. Material and equipment shall be the standard product of a manufacturer who has manufactured them for a minimum of 2 years and who provides published data on the quality and performance of the product.

B. A subcontractor for any part of the work must have experience on similar work and if required, furnish the Engineer with a list of projects and the Owners or Engineers who are familiar with his competence.

C. Devices, equipment, structures, and systems not designated by the Engineer that the Contractor wishes to furnish shall be designed by either a registered professional engineer or by someone the Engineer approves as qualified. If required, complete design calculations and assumptions shall be furnished to the Engineer or the Owner before acceptance.

D. All testing of the piping shall be made by the Contractor with equipment qualified by the Owner, Engineer, or utility company and in the presence of the Engineer, Owner, and utility company. The Engineer or his representative reserves the right to accept or reject testing equipment.

1.7 PRODUCT DELIVERY, STORAGE & HANDLING

Material shall be unloaded in a manner that will avoid damage and shall be stored where it will be protected and will not be hazardous to traffic. If stored on private property, the Contractor shall obtain permission from the property owner and shall repair any damage caused by the storage. Material shall be examined before installation and neither damaged nor deteriorated material shall be used in the work.

1.8 INSTALLATION PLAN

A. **At least 30 days prior to mobilizing equipment, Contractor shall submit his detailed installation plan to the Engineer. The plan shall include a detailed plan and profile of the bores and be plotted at a scale no smaller than 1-inch equals 20 feet horizontal and vertical.**

B. The plan shall also include a listing of major equipment and supervisory personnel and a description of the methods to be used.

C. The Contractor shall submit six (6) copies of the plan.

1.9 VARIATIONS IN PLAN OR PROFILE

The Contractor may make changes to the proposed vertical and horizontal alignment of the installation and the location of the entry and exit points, provided these changes are submitted in writing to the Engineer, and received approval of the Engineer prior to construction.

1.10 ALIGNMENT

The proposed plan and profile installation locations are based on alignments to accommodate future adjacent construction, to avoid obstructions, to properly maintain operation and stay outside of the Georgia EPD Vegetative Buffer.

1.11 GUARANTEE

The Contractor shall guarantee the quality of the materials, equipment, and workmanship for 12 months after acceptance of the completed Project. Defects discovered during that period shall be repaired by the Contractor, at no cost to the Owner. The Performance Bond shall reflect this guarantee.

1.12 EXISTING UTILITIES

All known utility facilities are shown schematically on plans and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities now shown on plans will not relieve the Contractor of his responsibility under this requirement. "Existing Utilities" means any utility that exists on the project in its original, relocated, or newly installed position. The Contractor will be held responsible for the cost of repairs to damaged underground utilities; even when such utilities are not shown on the plans. The Contractor shall contact all utility companies prior to beginning work and request an accurate field location of their respective utility lines.

1.13 MEASUREMENT AND PAYMENT

Payment will be made on a linear foot basis. Payment will include all equipment, labor, and material necessary to complete the work.

1.14 RECORD DATA

It will be required of the Contractor to keep accurate, legible records of the location of any deviations from the construction drawings, any additional items or structures to the construction drawings, and all utilities encountered which are not shown on the construction drawings. These records will be made available to the Engineer before his inspection for incorporation into the Engineer's Record Drawings.

1.15 SHOP DRAWINGS

The Contractor shall submit six (6) sets of shop drawings for each piece of equipment furnished under these specifications. Submittals shall be supported by descriptive materials, such as catalogs, cut sheets, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements; model numbers alone will not be acceptable.

All shop drawings shall be completely checked and marked accordingly by the Contractor prior to submitting such corrections as are necessary. Regardless of corrections made in or approval given to such drawings, the Contractor shall be responsible for the accuracy of such drawings and for their conformity to the plans and specifications unless he notifies the Engineer, in writing, of any deviations at the time he furnishes the drawings.

Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Where shop drawings are "make correction noted," such acceptance is tentative and is given with the understanding that the corrections indicated will be incorporated into the final product. Corrections indicated on shop drawings shall be incorporated into complete shop drawings. Rejected shop drawings shall not relieve the Contractor from the obligation to complete the project within the time allowed by the contract documents.

PART 2 – PRODUCTS

The materials and equipment used in the work shall conform to the following specifications:

2.1 Section 33 05 01.10 – HDPE Pipe and Fittings

PART 3 – EXECUTION

3.1 ON SITE OBSERVATIONS OF WORK

The Engineer or Project Representative shall have the right to require any portion of the work be completed in their presence. Any work covered up after such instruction shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer such work is scheduled, and the Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed, and materials furnished shall be subject to review by the Engineer or Project Representative. All improper work shall be reconstructed, and all materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. The Engineer shall have the right to mark rejected materials to distinguish them as such.

The Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notices for all required observations or tests.

3.2 INSTALLATION

A. General

1. The Contractor shall install the casing and force main by means of horizontal directional drilling as noted on plans.

2. Horizontal directional drilling shall consist of the drilling of a small diameter pilot hole from one end of the alignment to the other, followed by enlarging the hole diameter for the casing and pipeline insertion. The exact method and techniques for completing the directionally drilled installation will be determined by the Contractor, subject to the

requirements of these Specifications.

3. The casing and pipe shall be handled and installed in accordance with the pipe manufacturer's recommendations and AWWA standards.

B. Jointing Pipe Sections

1. Pipes shall be joined to one another by means of thermal butt–fusion. Polyethylene pipe lengths to be joined by thermal butt–fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier.
2. Mechanical connections of polyethylene pipe to auxiliary equipment shall be through Flanged connections which shall consist of the following:

   a. A polyethylene "sub end" shall be thermally butt–fused to the ends of the pipe.

   b. Provide ASTM A240, Type 304 stainless steel backing flange, 125–pound, ANSI B16.1 standard, and red rubber gaskets as required by the manufacturer.

   c. Stainless Steel bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the manufacturer's standard. Lubricate prior to assembly. Retorque the nuts after 4 hours.

   d. Butt–Fusion Joining: Butt–fusion of pipes shall be performed in accordance with the manufacturer's recommendations as to equipment and technique. Butt–fusion joining shall be 100% efficient offering a joint weld strength equal to or greater than the tensile strength of the pipe.

D. Tolerances

1. Pipe installed by the directional drilled method must be located in plan as shown on the Drawings and must be no shallower than shown on the Drawings unless otherwise approved. The Contractor shall plot the actual horizontal and vertical alignment of the pilot bore at intervals not exceeding 50 feet. This "as–built" plan and profile shall be updated as the pilot bore is advanced. The Contractor shall at all times provide and maintain instrumentation that will accurately locate the pilot hole and measure drilling fluid flow and pressure. The Contractor shall grant the Engineer access to all data and readout pertaining to the position of the bore head and the fluid pressures and flows. When requested, the Contractor shall provide explanations of the position monitoring and steering equipment. The Contractor shall employ experienced personnel to operate the directional drilling equipment and, in particular, the position monitoring and steering equipment. No information pertaining to the position or inclination of the pilot bores shall be withheld from the Engineer.

2. Each exit point shall be located as shown with an over–length tolerance of 40 feet and an alignment tolerance of 5 feet left/right with due

consideration of the position of the other exit points. The alignment of each pilot bore must be approved by the Engineer before pipe can be pulled. If the pilot bore fails to conform to the above tolerances, the Engineer may, at his option, require a new pilot boring to be made.

E. Ream and Pullback

1. Reaming: Reaming operations shall be conducted to enlarge the pilot after acceptance of the pilot bore. The number and size of such reaming operations shall be conducted at the discretion of the Contractor.

2. Pulling Loads: The maximum allowable pull exerted on the pipelines shall be measured continuously and limited to the maximum allowed by the pipe manufacturer so that the pipe or joints are not overstressed.

3. Torsion and Stresses: A swivel shall be used to connect the pipeline to the drill pipe to prevent torsional stresses from occurring in the pipe.

4. Pipeline Support: The pipelines shall be adequately supported during installation so as to prevent overstressing or buckling.

5. The Contractor shall at all times handle the pipe in a manner that does not overstress the pipe. Vertical and horizontal curves shall be limited so that wall stresses do not exceed 50% of yield stress for flexural bending of the pipe. If the pipe is buckled or otherwise damaged, the damaged section shall be removed and replaced by the Contractor at his expense. The Contractor shall take appropriate steps during pullback to ensure that the pipe will be installed without damage.

F. Handling Drilling Fluids and Cuttings

1. During the drilling, reaming, or pullback operations, the Contractor shall make adequate provisions for handling the drilling fluids for cutting the entry and exit pits. To the greatest extent practical, these fluids must not be discharged into the waterway. When the Contractor's provisions for storage of the fluids or cuttings on site are exceeded, these materials shall be hauled away to a suitable legal disposal site. The Contractor shall conduct his directional drilling operation in such a manner that drilling fluids are not forced though the subbottom into the waterway. After completion of the directional drilling work, the entry and exit pit locations shall be restored to original conditions. The Contractor shall comply with all permit provisions.

2. Pits constructed at the entry or exit point area shall be so constructed to completely contain the drilling fluid and prevent its escape to the beach, waterway, wetland, or marsh.

3. The Contractor shall utilize drilling tools and procedures which will minimize the discharge of any drilling fluids. The contractor shall comply with all mitigation measures listed in the required permits and elsewhere in these Specifications.

4. To the extent practical, the Contractor shall maintain a closed loop drilling fluid system.

5. The Contractor shall minimize drilling fluid disposal quantities by utilizing a drilling fluid cleaning system which allows the returned fluids to be reused.

6. As part of the installation plan specified herein before, the Contractor shall submit a drilling fluid plan which details types of drilling fluids, cleaning and recycling equipment, estimated flow rates, and procedures for minimizing drilling fluid escape.

3.3 DRILLING OPERATIONS

A. General

The Contractor shall prepare a plan to be submitted for Engineer approval which describes the noise reduction program, solids control plant, pilot hole drilling procedure, the reaming operation, and the pullback procedure. All drilling operations shall be performed by supervisors and personnel experienced in horizontal directional drilling. All required support, including drilling tool suppliers, survey systems, mud cleaning, mud disposal, and other required support systems used during this operation shall be provided by the Contractor.

Drill pipe shall be API steel drill pipe, Range 2, Premium Class or higher, Grade S–135 in a diameter sufficient for the torque and longitudinal loads and fluid capacities required for the work. Only drill pipe inspected under API's Recommended Practice Specification API RP 7G within 30 days prior to start and certified as double white band or better shall be used.

A smoothly drilled pilot hole shall follow the design centerline of the pipe profile and alignment described on the construction drawings.

The position of the drill string shall be monitored by the Contractor with the downhole survey instruments. Contractor shall compute the position in the X, Y and Z axis relative to ground surface from downhole survey data a minimum of once per length of each drilling pipe (approximately 51-foot interval). Serious deviations between the design position which may affect the installation of the pipeline which are beyond the control of the Contractor to correct shall be documented and immediately brought to the attention of the Engineer for discussion and/or approval. The profile and alignment defined on the construction drawings for the bores define the minimum depth and radius of curvature. At no point in the drilled profile shall the radius of curvature of the bore be less than 1 feet. The Contractor shall maintain and provide to the Owner or Engineer, upon request, the data generated by the downhole survey tools in a form suitable for independent calculation of the pilot hole profile.

During the entire operation, waste and leftover drilling fluids from the pits and cuttings shall be dewatered and disposed of in accordance with all permits and regulatory agencies requirements. Remaining water shall be cleaned by Contractor to meet permit requirements.

Technical criteria for bentonite shall be as given in API Spec. 13A, Specification for

Oil Well Drilling Fluids Material for fresh water drilling fluids. Any modification to the basic drilling fluid involving additives must describe the type of material to be used and to be included in Contractor's drilling plan presented to the Engineer. The Owner retains the right to sample and monitor the waste drilling mud, cuttings and water.

B. Environmental Provisions

The Horizontal Directional Drilling operation is to be operated in a manner to eliminate the discharge of water, drilling mud and cuttings to the adjacent land areas involved during the construction process. The contractor shall provide equipment and procedures to maximize the recirculation or reuse of drilling mud to minimize waste. All excavated pits used in the drilling operation shall be lined by Contractor with heavy duty plastic sheeting with sealed joints to prevent the migration of drilling fluids and/or ground water.

The general work areas on the entry and exit sides of the crossing shall be enclosed by a berm to contain unplanned spills or discharge.

Waste cuttings and drilling mud shall be processed through a solids control plant comprised of a minimum of sumps, pumps, tanks, desilter/desander, centrifuges, material handlers, and haulers all in a quantity sufficient to perform the cleaning/separating operation without interference with the drilling program. The cuttings and excess drilling fluids shall be dewatered and dried by the Contractor to the extent necessary for disposal in offsite landfills. Water from the dewatering process shall be treated by the Contractor to meet permit requirements and disposed of locally. The cuttings and water for disposal are subject to being sampled and tested. The construction site and adjacent areas will be checked frequently for signs of unplanned leaks or seeps.

Equipment (graders, shovels, etc.) and materials (such as groundsheets, haybales, booms, and absorbent pads) for cleanup and contingencies shall be provided in sufficient quantities by the Contractor and maintained at all sites for use in the event of inadvertent leaks, seeps or spills.

Waste drilling mud and cuttings shall be dewatered dried and stockpiled such that it can be loaded by a front–end loader, transferred to a truck and hauled offsite to a suitable legal disposal site. The maximum allowed water content of these solids is 50% of weight.

Due to a limited storage space and environmental sensitivity at the worksite, dewatering and disposal work shall be concurrent with drilling operations. Treatment of water shall satisfy regulatory agencies before it is discharged.

END OF SECTION

INDEX TO SECTION 33 10 00 – WATER UTILITIES

SECTION 33 10 00

WATER UTILITIES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Piping

B. Valves

C. Fittings

D. Connect to Existing System

E. All necessary appurtenances to convey potable water from existing system to the location shown on plans.

1.2 RELATED SECTIONS

A. Section 31 00 00 – Earthwork

B. Section 31 10 00 – Site Clearing

C. Section 32 92 00 – Turf and Grasses

1.3 OPTIONS

A. The bid form and specifications describe several pipe manufacturer and materials. Owner will select the one to be used. Where manufacturers of material or equipment are named in the specifications, Contractor may use equipment or materials of other manufacturers provided they are reviewed and accepted by Engineer as meeting specifications prior to ordering such equipment or materials.

1.4 REFERENCES (LATEST REVISION)

A. ASTM D 3740 – Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

B. ASTM E 329 – Agencies Engaged in Construction Inspection and/or Testing.

C. ANSI/AWWA C 153/A–21.53 – Ductile Iron Compact Fittings for Water Service.

D. ANSI/AWWA C 110/A21.10 – Ductile Iron and Gray Iron Fittings.

E. ANSI/AWWA C 150/A–21.50 – Thickness Design of Ductile Iron Pipe.

F. ANSI/AWWA C 151/A–21.51 – Ductile Iron Pipe, Centrifugally Cast for Water or other liquids.

G. ANSI/AWWA C 104/A–21.4 – Cement–Mortar Lining for Ductile Iron Pipe and Fittings for Water.

H. ASTM D 1784 – Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

I. ASTM D 2241 – Poly (Vinyl Chloride) (PVC) Pressure–Rated Pipe (SDR – Series).

J. ANSI/AWWA C 901 – Polyethylene (PE) Pressure Pipe and Tubing, 1/2 inch through 3 inch, for Water Service.

K. ASTM D 2737 – Polyethylene (PE) Plastic Tubing.

L. ANSI/AWWA C 115/A21.15 – Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.

M. ANSI/AWWA C 111/A21.11 – Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

N. ASTM D 3139 – Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

O. ANSI/AWWA C 900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 inch through 12 inch for Water Transmission and Distribution.

P. ANSI/AWWA C 500 – Metal–Seated Gate Valves for Water Supply Service.

Q. ANSI/AWWA C 509 – Resilient–Seated Gate Valves for Water Supply Service.

R. ANSI/AWWA C 502 – Dry–Barrel Fire Hydrants.

S. ANSI/AWWA C 800 – Underground Service Line Valves and Fittings.

T. ANSI/AWWA C 600 – Installation of Ductile Iron Water Mains and Their Appurtenances.

U. ANSI/AWWA C 605 – Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

V. ASTM D 2774 – Underground Installation of Thermoplastic Pressure Piping.

W. ASTM D 6938 – In–Place Density and Water Content of Soil and Soil – Aggregate By Nuclear Methods (Shallow Depth).

X. ANSI/AWWA C 651 – Disinfecting Water Mains.

Y. ASTM D 1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort.

Z. ANSI/AWWA C 504 – Rubber–Seated Butterfly Valves.

AA. ANSI B–18.2.2 – Square and Hex Bolts and Screws.

BB. ANSI B–18.2.2 – Square and Hex Nuts.

CC. NSF/ANSI 61 – Drinking Water System Components – Health Effects.

DD. ANSI/AWWA C 200 – Steel Water Pipe 6 Inch (150 mm) and Larger.

EE. ASTM A 53 – Pipe, Steel, Black and Hot–Dipped, Zinc–Coated, Welded and Seamless.

FF. ANSI/AWWA C 512 – Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.

GG. ANSI/AWWA C 905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 inch through 48 inch (350 mm through 1,200 mm), for Water Transmission and Distribution.

HH. ASTM A 139 – Electric–Fusion (Arc) – Welded Steel Pipe (NPS 4 and Over).

II. ANSI/AWWA C 515 – Reduced–Wall, Resilient–Seated Gate Valves for Water Supply Service.

1.5 QUALITY ASSURANCE

A. Materials – Contractor will furnish the Engineer and Owner a description of all material before ordering. Engineer will review the Contractor's submittals and provide in writing an acceptance or rejection of material.

B. Manufacturer – Material and equipment shall be standard products of a manufacturer who has manufactured them for a minimum of 2 years and who provides published data on quality and performance of the products.

C. Subcontractor – A subcontractor for any part of the work must have experience on similar work, and if required, furnish Engineer with a list of projects and Owners or Engineers who are familiar with its competence.

D. Design – If Contractor wishes to furnish devices, equipment, structures, and systems not designed by Engineer, these items shall be designed by either a Professional Engineer registered in the state of this project, or by someone Engineer accepts as qualified. If required, complete design calculations and assumptions shall be furnished to the Engineer or Owner before acceptance.

E. Testing Agencies – Soil testing shall be conducted by a testing laboratory which operates in accordance with ASTM D 3740 and E 329 latest revision and be acceptable to the Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided manufacturer maintains an adequate testing laboratory, makes regularly scheduled tests that are spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making the test.

F. Hydrostatic tests on pipe shall be made by Contractor with equipment qualified by the Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment. Hydrostatic testing shall be conducted in the presence of Engineer or Project Representative and a representative of water supplier.

1.6 REQUIREMENTS OF REGULATORY AGENCIES

A. Water mains shall be sterilized to meet requirements of the appropriate Health Department. Sterilization shall be in accordance with AWWA Standards C-651, latest revision.

1.7 PRODUCT DELIVERY, STORAGE & HANDLING

A. Material shall be unloaded in a manner avoiding damage and shall be stored where it will be protected and will not be hazardous to traffic. Contractor shall repair any damage caused by the storage. Material shall be examined before installation. Neither damaged nor deteriorated material shall be used in the work.

1.8 SEQUENCING AND SCHEDULING

A. Contractor shall arrange the work so sections of mains between valves are tested, sterilized, pavement replaced, and the section placed in service as soon as reasonable after installation.

1.9 ALTERNATIVES

A. The intention of these specifications is to produce the best system for the Owner. If Contractor suggests alternative material, equipment or procedures will improve the results at no additional cost, Engineer and Owner will examine suggestion, and if accepted, it may be used. The basis upon which acceptance of an alternative will be given is its value to the Owner, and not for the Contractor's convenience.

1.10 GUARANTEE

A. Contractor shall guarantee the quality of materials, equipment, and workmanship for a period of 12 months after acceptance. Defects discovered during this period shall be repaired by Contractor at no cost to the Owner.

1.11 EXISTING UTILITIES

A. All known utility facilities are shown schematically on the construction drawings and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities not shown will not relieve the Contractor of responsibility under this requirement. "Existing Utilities Facilities" means any utility existing on the project in its original, relocated, or newly installed position. Contractor will be held responsible for the cost of repairs to damaged underground facilities, even when such facilities are not shown on drawings.

B. Contractor shall call for underground utility locations before starting work. Underground utilities location service can be contacted at 811.

1.12 CONNECT NEW MAIN TO EXISTING SYSTEM

A. Contractor shall furnish the necessary pipe and perform all excavation, dewatering, shoring, backfilling, etc., necessary to make the connection of a new main to existing water system. Contractor shall contact the Superintendent of Water Utility a minimum of 48 hours in advance of construction. Contractor shall be responsible for coordinating construction with the utility operator.

1.13 DAMAGE TO EXISTING WATER SYSTEM

A. Damage to any part of the existing water system by Contractor or Subcontractors, repaired by Utility Owner's forces, shall be charged to Contractor on basis of time and material, plus 30% for overhead and administration.

1.14 MEASUREMENT AND PAYMENT

A. Measurement – The length of mains and branch lines to be paid for will be determined by measurement along the centerline of the various sizes and types of pipe actually furnished and installed, from the center of fitting, and from the center of the main to the end of the branch connection. No deduction will be made for the space occupied by valves and fittings.

B. Payment – Payment for pipe, fittings, valves, and other equipment will be paid based on the lump sum as tabularized on the bid form.

1.15 TESTING

A. Laboratory tests for moisture density relationship for fill materials shall be in accordance with ASTM D 1557, (Modified Proctor).

B. In place density tests in accordance with ASTM D 6938.

C. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

D. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48 hours notice prior to taking any tests.

E. Testing shall be the owner responsibility (the Contractor's will only pay for the failed tests).

F. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

PART 2 – PRODUCTS

Products and materials used in work shall conform to the following:

2.1 PIPE

A. Ductile Iron Pipe – Shall conform to ANSI A–21.50 (AWWA C–150) and ANSI A–21.51 (AWWA C–151). All pipe shall be Pressure Class 350 unless otherwise noted. It shall be cement lined in accordance with ANSI A–21.4 (AWWA C–104).

B. P.V.C. – All pipe shall be blue in color with factory marked homing lines. Pipe 4 inches through 12 inches shall conform to all requirements of AWWA C–900, DR 18, pressure class of 235 p.s.i. and shall have the following minimum wall thickness:

4 inches	0.267 inches
6 inches	0.383 inches
8 inches	0.503 inches
10 inches	0.617 inches
12 inches	0.733 inches

PVC pipe 14 inches through 18 inches shall conform to all requirements of AWWA C905 with CI outside diameter, DR 18, with a pressure rating of 235 p.s.i.

Pipe with diameter less than 4 inches shall conform to all requirements of ASTM D–1784 and D–2241 (SDR 21). The pipe shall have a minimum pressure rating of 200 p.s.i. Certificates of conformance with the foregoing specifications shall be furnished with each lot of pipe supplied. All P.V.C. pipe shall bear the National Sanitation Foundation Seal of Approval.

C. Plastic Tubing – Tubing for service lines shall be:

Polyethylene Tubing: CTS PE 3408 conforming to all requirements of AWWA C–901 and ASTM D–2737 (SDR9). The tubing shall be copper tubing size and rated for a minimum working pressure of 200 p.s.i. Marking on the tubing shall include nominal tubing pipe size; type of tubing material – PE 3408; SDR 9; pressure rating – 200 p.s.i.; ASTM D–2737; manufacturer's name and seal of the National Sanitation Foundation.

2.2 JOINTS

A. Flanged Joints – Shall conform to ANSI A–21.15 (AWWA C–115). Bolts shall conform to ANSI B–18.2.1 and nuts shall conform to ANSI B–18.2.2. Gaskets shall be rubber, either ring or full face, and shall be 1/8 inch thick. Gaskets shall conform to the dimensions recommended by AWWA C–115 latest revision.

B. Mechanical Joints – In ductile iron pipe shall conform to ANSI A–21.11 (AWWA C–111).

C. Push–On–Joints – In ductile iron pipes shall conform to ANSI A–21.11 (AWWA C–111).

D. Plastic Pipe – Joints in plastic pipe 4 inches through 12 inches shall meet all requirements of AWWA C–900. Joints in plastic pipe 14 inches through 18 inches shall meet all requirements of AWWA C905. Joints in plastic pipe with a diameter less than 4 inches shall conform to ASTM D–3139.

E. Restrained Joints – Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push–on type joints equivalent to "Lok–Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure equal to the item restrained with a minimum safety factor of 2:1. The joints shall be in accordance with the applicable portions of AWWA C–111. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

F. Natural rubber or other material which will support microbiological growth may not be used for any gaskets, o–rings, and other products used for jointing pipes, setting meters, and valves or other appurtenances which will expose such material to water.

2.3 FITTINGS

A. Fittings for Ductile Iron or Plastic Pipe – Shall be ductile iron, manufactured in accordance with ANSI A–21.53 (AWWA C–153). They shall be cement lined in accordance with ANSI A–21.4 (AWWA C–104). Fittings shall be designed to accommodate the type of pipe used.

B. Fittings for Flanged Pipe – Shall be manufactured in accordance with ANSI A–21.10 (AWWA C–110), Class 125 flanges.

C. Fittings for Plastic Pipe – Less than 4 inches shall be PVC with ring tite rubber joints conforming to ASTM D–3139.

2.4 GATE VALVES

A. Two Inches and Larger – Shall be cast iron or ductile iron body, bronze mounted, double disc or resilient wedge design, with non–rising stems, conforming to AWWA C–500, C–509, or C–515. Valves shall have a working pressure of 200 p.s.i. and be tested at 400 p.s.i.

Valves shall be furnished with "O" ring packing. Two "O" rings shall be located above the thrust collar and one "O" ring below. The thrust collar shall be permanently lubricated and have an anti–friction washer on top of the thrust collar.

Valves installed in pits or above ground shall be furnished with hand wheels. Buried valves shall be furnished with square operating nuts.

B. Smaller Than 2 Inches – Shall be all brass, ball valve type. The pressure rating shall be 175 p.s.i.

C. Valve Boxes – Underground valves shall be installed in acceptable valve boxes. The valve boxes shall have a suitable base which does not damage the pipe, and shaft extension sections to cover and protect the valve and permit easy access and operation. The box, cover and any extensions needed shall be cast or ductile iron having a crushing strength of 1,500 pounds per linear foot. Valve boxes shall conform to the detail shown.

D. Valve Manholes

1. Masonry – Shall be new whole brick of good quality laid in masonry mortar or cement made of one part Portland cement and two parts clean sharp sand. Every brick shall be fully bedded in mortar. Manholes shall conform to the locations and details shown on the plans.

2. Precast Concrete – Shall be reinforced concrete constructed in accordance with ASTM C 478 and the details shown on the plans "Precast Concrete Manholes." The joints shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O–Ring or equivalent to Type A or B "Tylox" conforming to ASTM C 443. Mastic shall be equivalent to "Ram–nek" with primer. The primer shall be applied to all contact surfaces of the manhole joint at the factory in accordance with the manufacturer's instructions.

3. Frames and Covers – Shall be cast iron equivalent to the following:

   Neenah Foundry Co. R–1668 Type "C" Lid

E. Flush valves – Shall conform to the details shown.

2.5 BUTTERFLY VALVES

A. All butterfly valves shall be of the tight–closing, rubber seated type, with rubber seat positively locking in place sealing against flow from either direction. No metal–to–metal seating surfaces will be permitted. Valves shall be bubble–tight at rated pressures with flow in either direction. Butterfly valves shall conform to ANSI/AWWA C504, Class 150B. Butterfly valves shall not be used on pipe smaller than 14–inches unless otherwise specified.

1. Valve body end connections for buried valves shall be installed using restrained joints equivalent to those manufactured by EBAA Iron, Inc.

2. Valve shafts shall be stainless steel and may consist of a one–piece unit or may be the "Stub Shaft" type. A stub shaft comprises two separate shafts inserted into the valve disc hubs. Each stub shaft shall be inserted into the valve disc hubs for a distance of at least 1½ shaft diameters.

3. Valve discs shall be solid ductile iron with an epoxy coating making it corrosion resistant. The thickness of the discs shall not exceed 2¼ times the shaft diameter.

4. Valve seats shall be natural or synthetic rubber providing 360 degrees uninterrupted seating. The resilient seat shall be adjustable or replaceable in the field without burning or grinding. The seat shall be molded over a stainless steel ring for support and secured to the disc by corrosion resistant, self locking stainless steel screws.

5. All internal ferrous metal surfaces in the waterway shall be factory coated with a non–toxic, to–component, holiday–free, thermosetting epoxy to a nominal thickness of 4 mils.

6. All butterfly valves shall be manually operated. Operators shall be of the traveling nut, self–locking type and shall be designed to hold the valve in any intermediate position without creeping or fluttering. Operators shall be furnished with externally adjustable mechanical stop limiting devices. Valves shall have a 2 inch square operating nut and shall be installed with extension stem to extend the operating nut in accordance with the project details. The operator shall be integrally mounted on the valve

mounting flange and shall have a gearing totally enclosed for buried service. Maximum force for operating nut shall be 40 pounds.

B. Valve Boxes – Underground valves shall be installed in approved valve boxes. The valve boxes shall have a suitable base that does not damage the pipe, and shaft extension sections to cover and protect the valve and permit easy access and operation. The cover, box, and any extensions needed shall be cast or ductile iron having a crushing strength of 1,500 pounds per linear foot. Valve boxes shall conform to the detail shown.

C. Valve Manholes –

1. Masonry – Shall be new whole brick of good quality laid in masonry mortar or cement made of one part Portland cement and two parts clean sharp sand. Every brick shall be fully bedded in mortar. Manholes shall conform to the locations and details shown on the plans.

2. Precast Concrete – Shall be reinforced concrete constructed in accordance with ASTM C 478 and the details shown on the plans "Precast Concrete Manholes." The joints shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O–Ring or equivalent to Type A or B "Tylox" conforming to ASTM C 443. Mastic shall be equivalent to "Ram–nek" with primer. The primer shall be applied to all contact surfaces of the manhole joint at the factory in accordance with the manufacturer's instructions.

3. Frames and Covers – Shall be cast iron equivalent to the following:

   Neenah Foundry Co. R–1668 Type "C" Lid

2.6 FIRE HYDRANTS

A. General – Hydrants shall be manufacturer's current model design and construction. All units to be complete including joint assemblies. Physical characteristics and compositions of various metal used in the hydrant components shall meet the requirements as specified in AWWA C–502 latest revision. Hydrants shall be suitable for working pressure of 150 p.s.i.

B. Bonnet – Bonnet may have oil filled or dry reservoir. If oil filled, bonnet must have "O" ring packing so all operating parts are enclosed in a sealed oil bath. Oil filler plug shall be provided in bonnet to permit checking of oil level and adding oil when required. If dry type, hydrant top must have lubricating hole or nut for ease of lubrication. All parts must be removed through top of hydrant without moving entire barrel section from safety flange.

C. Nozzles and Caps – The hydrant shall have two 2–1/2 inch connections and one 4–1/2 inch steamer connection, National standard threads. Nozzles shall be bronze and have interlocking lugs to prevent blowout. Nozzle caps shall be secured to fire hydrant with non–kinking type chain with chain loop on cap ends to permit free turning of caps.

D. Seat Ring – Seat ring shall be bronze.

E. Drain Valves and Openings – Positive operating drain valves shall be provided to assure drainage of fire hydrant when the main valve is closed. Drain openings shall have bronze bushings.

F. Main Valve – Valve shall be designed to close with the pressure and remain closed. Valve shall be made from material resisting damage from rocks or other foreign matter. Valve shall have a full 4-1/2 inch opening.

G. Barrel and Safety Flanges – Hydrants shall have a safety-type vertical barrel with 4 foot bury and be designed with safety flanges and/or bolts to protect the barrel and stem from damage and to eliminate flooding when hydrant is struck. Bury depth shall be cast on barrel of hydrant.

H. Operating Stop and Nut – Hydrant shall have a positive stop feature to permit opening of hydrant without over travel of stem. Operating nut shall be bronze 1 1/2 inch, point to flat, pentagon.

I. Bolts and Nuts – Bolts, washers and nuts shall be corrosion resistant.

J. Inlet – Bottom inlet of hydrant shall be provided with mechanical joint connection as specified and shall be 6 inch nominal diameter.

K. Direction of Opening – Hydrant shall be designed to close "right" or clockwise and open "left" or counter–clockwise.

L. Coatings – All inside and outside portions of hydrant shall be coated in accordance with AWWA C–502. The exterior portion of hydrant above ground level shall be painted with two coats of best grade zinc chromate primer paint and with two coats of approved hydrant enamel. Color shall be Federal Safety Yellow unless otherwise designated by Owner.

M. Joint Assemblies – Complete joint assemblies consisting of gland, gasket, bolts, and nut shall be furnished for mechanical joint inlets.

2.7 SERVICE CONNECTIONS

A. Taps in pipe larger than 3 inches shall be made with a tapping machine. A corporation stop shall be installed at the connection to the main. The corporation stop shall be brass manufactured in conformance with AWWA C–800. Inlet and outlet threads shall conform to AWWA C–800.

Corporation stops shall be 1 inch equivalent to Mueller H–15008 or B–25008 with a stainless steel stiffener. Service saddles shall have 1 inch AWWA taps, equivalent to Ford Styles 202B or S70. Contractor shall adhere to pipe manufacturer's recommendations on maximum tap sizes for each main size.

B. Taps for services in PVC pipe 3 inches and smaller shall be equivalent to Romac Industries Style 306 Saddle or made with a PVC Tee. The connection shall be capable of withstanding internal water pressure continuously at 150 p.s.i. House service lines will be 1 inch polyethylene tubing with a curb stop at the property line. The end of the service lateral at the property line shall be marked with a 2 x 4 stake, 36 inches long with the top 6 inches above the ground and painted blue.

The depth of the pipe shall be marked on the back of the stake. Location of service line must appear on the "as–built" information and record drawings.

2.8 TAPPING SLEEVES

A. Cast or Ductile Iron – Shall be mechanical joint type sized to fit the intercepted pipe. They shall have duck–tipped end gaskets and shall be equivalent to Mueller H–615/715 with a tapping valve attached. Outlet end of valve shall have a joint suitable for type of pipe installed in the new branch. Sleeve shall be sized to fit the intercepted pipe without leaking.

B. Stainless Steel – Shall be all stainless steel construction with full circumferential gasket equivalent to JCM 432 with a tapping valve attached. Outlet end of valve shall have a joint suitable for type of pipe installed in the new branch. Sleeve shall be sized to fit the intercepted pipe without leaking.

2.9 CURB STOPS

A. At the end of the service line, where the meter is to be installed, a 1 inch brass ball valve with padlock wing shall be installed. The unconnected end shall be closed inside I.P. thread. All ball valves shall be 1/4 turn and the full open and closed position shall be controlled by check lugs. The pressure rating shall be 175 p.s.i. The ball valves shall be equivalent to Ford Ball Valve No. B41–444W.

2.10 METAL DETECTOR TAPE

A. The tape shall consist of 0.35 mils thick solid foil core encased in a protective plastic jacket resistant to alkalis, acids, and other destructive elements found in the soil. The lamination bond shall be strong enough that the layers cannot be separated by hand. Total composite thickness to be 5.0 mils. Foil core to be visible from unprinted side to ensure continuity. The tape shall have a minimum 3 inch width and a tensile strength of 35 lbs. per inch.

A continuous warning message indicating "potable water" repeated every 16 inches to 36 inches shall be imprinted on the tape surface. The tape shall contain an opaque color concentrate designating the color code appropriate to the line being buried (Water Systems – Safety Precaution Blue).

2.11 BACKFLOW PREVENTER ASSEMBLY

A. Reduced Pressure – Shall consist of two independently operating check valves, one differential relief valve located between the two check valves, two resilient seat gate valves, and four properly placed resilient seated test cocks. Backflow preventer 2 inches and smaller shall have a bronze valve body. Backflow preventer greater than 2 inches shall be ductile iron or stainless steel. All internal parts in the check and relief valves shall be made of series 300 stainless steel or polymer materials suitable for potable water and rated for 175 p.s.i. working pressure. The assembly shall be constructed so all internal parts can be serviced or removed while in line. Assembly must be factory assembled and tested. Backflow preventer shall be equivalent to Febco Model 860 or Ames Model 4000 SS.

B. Double Check – Shall consist of two independently operating check valves, two resilient seat gate valves, and four properly placed resilient seated test cocks. Backflow preventer 2 inches and smaller shall have a bronze valve body. Backflow preventer greater than 2 inches shall be ductile iron or stainless steel. All internal parts in the check valves shall be made of Series 300 stainless steel or polymer materials suitable for potable water and rated for 175 p.s.i. working pressure. The assembly shall be constructed so all internal parts can be serviced or removed while in line. Assembly must be factory assembled and tested. Backflow preventer shall be equivalent to Febco Model 805YD or Ames Model 2000 SS.

2.12 TRACING WIRE

A. Tracing wire shall be # 12 gauge insulated single strand copper wire.

2.13 CASING

A. Casing pipe shall be steel conforming to ASTM A 139, yield point of 35,000 p.s.i., of the diameter shown on the contract drawings for each crossing. The minimum wall thickness shall be 0.25 inches.

2.14 CASING SPACERS

A. Casing spacers shall be bolt on style with a shell made in two sections of a minimum 14 gauge T–304 Stainless Steel. Connecting flanges shall be ribbed for extra strength. The shell shall be lined with a PVC liner. All nuts and bolts shall be T–304 Stainless Steel. Runners shall be made of Ultra High Molecular Weight Polymer with inherently high abrasion resistance and a low coefficient of friction. The combined height of supports and runners shall keep carrier pipe a minimum of 0.75 inches from casing pipe at all times. Casing Spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, or accepted equivalent.

2.15 AIR RELEASE, AIR/VACUUM, AND COMBINATION AIR VALVES

A. Shall be designed for water service with a minimum working pressure of 100 p.s.i. The valve shall be constructed of a cast iron body, stainless steel or bronze trim, and stainless steel float. The inlet shall be 2 inches, 5/16 inch orifice, and a minimum venting capacity of 35 c.f.f.a.m. It shall conform to the detail shown on the drawings. Valves shall conform to AWWA C 516 and equivalent to Crispin or Valmatic.

2.16 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer will review all products before they are ordered.

PART 3 – EXECUTION

3.1 ON–SITE OBSERVATION

A. Owner's Representative or Engineer shall have the right to require any portion of work be completed in their presence. If any work is covered up after such instruction, it shall be exposed by the Contractor for observation. However, if Contractor notifies Engineer such work is scheduled, and Engineer fails to appear within 48 hours, Contractor may proceed. All work completed and materials furnished shall be subject to review by the Engineer or Project Representative. All improper work shall be reconstructed. All materials which do not conform to requirements of specifications shall be removed from the work upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

Contractor shall give the Project Engineer or Project Representative a minimum of 48–hours notice for all required observations or tests.

It will also be required of Contractor to keep accurate, legible records of the location of all water lines, service laterals, valves, fittings, and appurtenances. These records will be prepared in accordance with the paragraph on "Record Data and Drawings" in Special Conditions. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.2 INSTALLATION

A. Ductile iron pipe shall be laid in accordance with AWWA C–600; Plastic pipe shall be laid in accordance with AWWA C 605, ASTM D 2774, UNI–Bell UNI–B 3, and the pipe manufacturer's recommendations. The standards are supplemented as follows:

1. Depth of Pipe – Contractor shall perform excavation of whatever substances are encountered to a depth providing a 36" minimum cover over top of pipes up to 12" in diameter and 48" minimum cover over top of pipes larger than 12".

2. Alignment and Grade – Water mains shall be laid and maintained to lines and grades established by the plans and specifications, with fittings, valves, and hydrants at required locations unless otherwise accepted by Owner. Valve–operating stems shall be oriented in a manner to allow proper operation. Hydrants shall be installed plumb.

   a. Prior Investigation – Prior to excavation, investigation shall be made to the extent necessary to determine location of existing underground structures, utilities, and conflicts. Care shall be exercised by the Contractor during excavation to avoid damage to existing structures and utilities. Pipe manufacturer's recommendations shall be used when the watermain being installed is adjacent to a facility cathodically protected.

   b. Unforeseen Obstructions – When obstructions not shown on plans are encountered during progress of work, and interfere so a change of the plans is required, Engineer will revise plans, or order a deviation in line and grade, or arrange for removal, relocation, or reconstruction of obstructions.

   c. Clearance – When crossing existing pipelines or other structures, alignment and grade shall be adjusted as necessary, with the acceptance of Engineer, to provide clearance as required by federal, state, and local regulations or as deemed necessary by Engineer to prevent future damage or contamination.

3. Trench Construction – The trench shall be excavated to alignment, depth, and width specified or shown on plans and shall be in conformance with all federal, state, and local regulations for protection of workers.

4. Joint Restraint – All bends, plugs, valves, caps and tees on 2–inches pipe and larger, shall be provided with stainless steel tie rods or joint restraints equivalent to Megalugs. Additional restraint shall be as indicated on the drawings.

5. Anchorage for Hydrants – A concrete block 1 foot x 1 foot x 2 feet shall be poured between back of hydrant and undisturbed earth of the trench side without covering weep holes and bolts. Joint restraints equivalent to Megalugs manufactured by EBAA Iron may be used in lieu of concrete blocking.

6. Hydrostatic and Leakage Tests – Ductile iron pipe shall be tested in accordance with AWWA Standard C 600, Section 5.2 – Hydrostatic Testing. Allowable leakage shall not exceed the formula $L = SDP^{1/2}/148{,}000$, in which L is allowable leakage in gallons per hour; S is length of pipe in feet tested; D is nominal diameter of the pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least 2 hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

   P.V.C. pipe shall be tested in accordance with AWWA Standard C 605, Section 7.3 – Hydrostatic Testing. Allowable leakage shall not exceed the formula $Q = LDP^{1/2}/148{,}000$, in which Q is allowable leakage in gallons per hour; L is length of pipe in feet tested; D is nominal diameter of the pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least 2–hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

   Should any test of pipe laid disclose leakage greater than the above specified, Contractor shall at its own expense, locate and repair defective joints until leakage is within specified allowance. Contractor is responsible for notifying the Engineer 48 hours (minimum) prior to applying pressure for testing. Pressure test will be witnessed by the Engineer or Project Representative. All visible leaks shall be repaired regardless of the leakage amount.

7. Bedding, Backfilling and Compaction – Continuous and uniform bedding shall be provided for all buried pipe. All trenches and excavation shall be backfilled immediately after pipes are laid therein, unless other protection of the pipe line is directed. The backfilling material shall be selected and deposited with special reference to future safety of pipes. The material shall be completely void of rocks, stones, bricks, roots, sticks, or any other debris causing damage to pipe and tubing or preventing proper compaction of backfill. Except where special methods of bedding and

tamping are provided for, clean earth or sand shall be solidly tamped about pipe up to a level at least 2 feet above top of pipes, and shall be carefully deposited to uniform layers, each layer solidly tamped or rammed with proper tools to not injure or disturb the pipeline. The remainder of trench backfilling shall be carried on simultaneously on both sides of pipe in such manner preventing injurious side pressure. Material used shall be selected from excavations anywhere on site if any of the soil is suitable.

Under traffic areas, the top 24 inches of backfill material shall be compacted to a density of not less than 98% of maximum laboratory density at optimum moisture as determined by ASTM D 6938. Below the 24 inch line, and including area around pipe, density shall not be less than 95% of maximum laboratory density, at optimum moisture. In areas other than traffic areas, the backfill shall be compacted to 90% of maximum laboratory density at optimum moisture.

Whenever trenches have not been properly backfilled, or if settlement occurs, they shall be refilled, smoothed off, and finally made to conform to the ground surface. Backfilling shall be carefully performed, and original surface restored to the full satisfaction of Engineer immediately after installation.

Where thermoplastic (PVC) pipe is installed, Contractor shall take precautions, in accordance with ASTM D-2774, during backfilling operations not to create excessive side pressures, or horizontal or vertical deflection of the pipe, nor impair flow capacity.

8. New Service Connections – Contractor shall tap the main and install a service connection to each lot or as directed by Engineer in accordance with details shown on plans for Water Service Connections. Plastic tubing for service lines shall be installed in a manner preventing abrupt changes or bends in any direction. Contractor shall exercise extreme caution to prevent crimping of the tubing during handling, storage, and installation. Tubing shall have an absolute positive connection to the water main to prevent leakage. Taps shall be made perpendicular to the main. A water service connection shall be marked on the curb with a "W." The mark shall be made with a branding iron on vertical face of curb and shall be a minimum of 1/4 inch in depth.

9. Detection Tape – Detection tape will be used over all pipe and tubing. The tape shall be laid 18 inches below finished grade.

10. Tracing Wire – Tracing wire will be installed on all water mains and water service laterals directly on top of the water line. The wire shall be secured to the pipe with tape or other acceptable methods at spacings of no more than 36 inches apart. Where water service laterals connect to water mains, the wire insulation shall be stripped so bare wires can and shall be jointed securely together and wrapped with a rubberized insulation tape. The insulated wire must maintain electrical continuity. The tracing wire shall also be stubbed up into each valve box and at each fire hydrant. Stub up connections shall be stripped, joined, and wrapped as previously described for water service laterals. This tracing wire system

shall be checked and tested by Contractor, in the presence of Engineer or water department, prior to acceptance of water main installation. All equipment, meters, detectors, etc., needed for testing shall be furnished by the Contractor.

11. Jacking and Boring – Steel casing of diameter shown on the plans shall be jacked and bored in location indicated. Joints between sections of the steel casing shall be of a continuous weld made by a certified welder. Jacking and boring shall be in accordance with the State Department of Transportation Standard Specifications. Carrier pipe shall be installed as shown on the detail. After carrier pipe has been installed, ends of the casing shall be sealed using a rubber enclosure and stainless steel straps or brick and mortar.

    Where work involves a highway, Resident Engineer of the State Department of Transportation shall be notified 3 days before crossing is started. Where the work involves a railroad, installation shall conform to requirements of AREA specifications. Division Superintendent of the Railroad shall be notified three 3 days prior to beginning work. Before commencing work within right–of–way of railroads or highways, Contractor shall verify the Owner has obtained required permits.

3.3 AIR RELEASE, AIR/VACUUM, AND COMBINATION AIR VALVES

A. Valves shall be installed in locations as shown on the contract drawings. The Contractor shall verify high points in the water line and notify Engineer of differing conditions from the drawings.

B. Valves shall be opened during initial filling of the water main. Valves shall be closed during hydrostatic testing. Once tested and the system is accepted for operation, valves shall be opened when water lines are put on line.

3.4 CONNECTIONS OF WATER MAINS

A. Any physical connection of untested water mains with existing water mains is prohibited except when acceptable backflow prevention devices have been installed and checked by Engineer or Engineer's Representative.

    1. Any new water main to be tested must be capped and restrained with retaining glands or thrust blocks to prevent blow out or leakage during the pressure testing.

    2. Water for filling or flushing a new water main will be obtained through a Temporary Jumper Connection to the existing main. Appropriate taps of sufficient size must be made at the end of new system to allow air to escape during filling sequence.

    3. This physical tie–in with the existing system must be physically disconnected after sufficient water for hydrostatic testing and disinfection has been obtained.

    4. Once the new water system has demonstrated adequate hydrostatic testing and has been flushed and chlorinated in accordance with

paragraph 3.5, the new system or main will then be subjected to bacteriological testing.

5. Permanent connection to the new system must be made with clean materials. The connection may be made with either solid or split ductile iron sleeves. Any connection with stainless steel or similar metal full circle clamps is prohibited. Once connection has been made, the new system must be flushed using water from existing system to insure adequate flow and velocity into new water system.

3.5 DISINFECTION

A. After hydrostatic and leakage tests have been completed, water pipes shall be disinfected and tested in accordance with AWWA C 651 and Regulations of the local Health Department.

All new mains shall be thoroughly flushed then chlorinated with not less than fifty parts per million (50 ppm) of available chlorine. Chlorine gas or 70% high–test calcium hypochlorite can be used. Water from existing distribution system or other source of supply should be controlled to flow slowly into the newly laid pipeline during application of chlorine. The solution shall be retained in pipeline for not less than 24 hours and a chlorine residual of 25 ppm shall be available at this time. Then system shall be flushed with potable water and the sampling program started. The chlorine residual during sampling shall be between 0.5 and 1.5 ppm.

After final flushing and before new water main is connected to the distribution system, two consecutive sets of bacteriologically acceptable samples, taken at least 24 hours apart, shall be collected from new main. One set of samples shall be collected from every 1,200 feet of new water main, plus one set from end of the line and at least one set from each branch. All samples shall be tested for bacteriological (chemical and physical) quality in accordance with standard methods for examination of water and wastewater; and shall show the absence of coliform organisms. The results, clearly showing sample locations, non–coliform growth, coliform growth, and chlorine residuals, shall be submitted to Engineer by Contractor.

3.6 PARTIAL ACCEPTANCE OF THE WORK

A. Owner reserves right to accept and use any part of the work. Engineer shall have power to direct on what line Contractor shall work and the order thereof.

3.7 GRASSING

A. Grassing of areas disturbed during construction shall be in accordance with the Section 32 92 00 "Turf and Grasses."

3.8 SEPARATION BETWEEN WATER AND SANITARY SEWER

A. Parallel Installation:

1. Water mains shall be laid at least 10 feet horizontally from any existing or proposed sanitary sewer, force main, storm sewer, or sewer manhole. The distance shall be measured edge–to–edge.

2. When conditions prevent a horizontal separation of 10 feet, the water main may be laid closer to a sewer (on a case–by–case basis) provided the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation where the bottom of the water main is at least 18 inches above the top of the sewer. It is advised the sewer to be constructed of materials and with joints equivalent to water main standards of construction and be pressure tested to assure water–tightness prior to backfilling. Another alternative is to incase the sewer line in an excavatable mix of concrete.

B. Crossing:

1. Water mains crossing house sewers, storm sewers, or sanitary sewers shall be laid to provide a separation of at least 18 inches between the bottom of the water main and the top of the sewer. At the crossings, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

2. When conditions prevent a vertical separation of 18 inches, the sewer passing over or under water mains shall be constructed of materials and with joints equivalent to water main standards of construction and shall be pressure tested to assure water–tightness prior to backfilling.

3. When water mains cross under sewers, additional measures shall be taken by providing:

   a. A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main;

   b. Adequate structural support for the sewers to prevent excessive deflection of joints settling on and breaking the water mains;

   c. The length of water pipe be centered at the point of crossing so the joints will be equidistant and as far as possible from the sewer; and

   d. Both the sewer and water main shall be constructed of water pipe and subjected to hydrostatic tests, as prescribed in this document. Encasement of the water pipe in concrete shall also be considered.

3.9 REMOVE AND REPLACE PAVEMENT

A. Pavement shall only be removed after prior written authorization by the Owner. Pavement removed and replaced shall be constructed in accordance with latest specifications of the State Department of Transportation. Traffic shall be maintained and controlled per State Department of Transportation regulations.

Edges of the pavement shall be cut to a neat straight line with a masonry saw. Backfill shall be compacted and tested and a concrete base course of 5,000 p.s.i. placed on compacted fill as shown in the details. The concrete base shall be placed within 24 hours after water line is installed. A temporary wearing surface may be used provided it presents a smooth surface. The final wearing surface shall be 1–1/2 inches of 12.5 mm Superpave asphaltic concrete.

3.10 FIELD QUALITY CONTROL

A. Soil and density tests shall be made by a testing laboratory acceptable to Engineer. Laboratory tests of the soil shall be made in accordance with ASTM D 1557. In–place density tests shall be made in accordance with ASTM D 6938. Results of tests shall be furnished to the Engineer.

The minimum number of tests required shall be:

Backfill over pipe
in traffic areas. . . . . 1 per 100 linear feet or less for each 4 feet of depth or portion thereof.

Backfill over pipe
in non–traffic areas. . . . .1 per 500 linear feet or less for each 4 feet of depth or portion thereof.

The minimum percent of backfill, compaction, in accordance to ASTM D1557, shall be the following:

In traffic Areas. . . . . 98% of maximum laboratory density.

In non–traffic Areas. . . . . . 90% of maximum laboratory density, unless otherwise accepted by the Engineer.

END OF SECTION

INDEX TO

SECTION 33 30 00 – SANITARY SEWERAGE UTILITIES

Paragraph	Title	Page

PART 3 – EXECUTION

SECTION 33 30 00

SANITARY SEWERAGE UTILITIES

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Sewer Pipes.

B. Manholes.

C. Connect to existing system.

D. All necessary appurtenances to collect the sanitary sewerage and deliver it to the existing system.

E. Pumping Station

F. Force Main

1.2 RELATED SECTIONS

A. Section 31 00 00 – Earthwork.

B. Section 31 10 00 – Site Clearing

C. Section 32 92 00 – Turf and Grasses

D. Section 33 10 00 – Water Utilities.

1.3 OPTIONS

A. The specifications describe several materials. The Owner will select ones to be used. Where manufacturers and models of equipment are named in the specifications, it is intended these are to describe quality and function required. Contractor may use equipment or materials of other manufacturers provided they are reviewed and accepted by the Engineer and Owner as equivalent to those specified.

1.4 REFERENCES (Latest Revision)

A. ASTM D 3740 – Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.

B. ASTM E 329 – Agencies Engaged in Construction Inspection and/or Testing.

C. ASTM D 3034 – Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

D. ASTM D 2321 – Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity–Flow Applications.

E. ANSI/AWWA C 150/A 21.50 – Thickness Design of Ductile Iron Pipe.

F. ANSI/AWWA C 151/A 21.51 – Ductile Iron Pipe, Centrifugally Cast, for Water, or other liquids.

G. ASTM A 746 – Ductile Iron Gravity Sewer Pipe.

H. ASTM D 3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

I. ASTM F 477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

J. ASTM D 2241 – Poly (Vinyl Chloride) (PVC) Pressure–Rated Pipe (SDR Series).

K. ASTM D 3139 – Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

L. ASTM A 139 – Electric–Fusion (Arc) Welded Steel Pipe (NPS 4 and Over).

M. ASTM C 478 – Precast Reinforced Concrete Manhole Sections.

N. ASTM C 443 – Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

O. ACI 318 – Building Code Requirements for Structural Concrete.

P. ASTM C 39/C 39M – Compressive Strength of Cylindrical Concrete Specimens.

Q. ASTM C 890 – Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

R. ASTM C 891 – Installation of Underground Precast Concrete Utility Structures.

S. ASTM C 913 – Precast Concrete Water and Wastewater Structures.

T. ASTM A 615/A 615 M – Deformed and Plain Carbon – Steel Bars for Concrete Reinforcement.

U. ANSI/AWWA C–500 – Metal–Seated Gate Valves for Water Supply Service.

V. ANSI/AWWA C–509 – Resilient–Seated Gate Valves for Water Supply Service.

W. ASTM D–6938 – In–Place Density and Water Content of Soil and Soil–Aggregate By Nuclear Methods (Shallow Depth).

X. ASTM D–1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort.

Y. ASTM D 714 – Evaluating Degree of Blistering of Paints.

Z. ASTM D 2794 – Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

AA. ASTM E 96 – Water Vapor Transmission of Materials.

BB. ASTM G 154 – Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

CC. ANSI/AWWA C 111/A 21.11 – Rubber–Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

DD. ASTM A 377 – Index of Specifications for Ductile Iron Pressure Pipe.

EE. ANSI/AWWA C 600 – Installation of Ductile Iron Water Mains and their appurtenances.

FF. ANSI/AWWA C115/A21.15 – Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.

GG. ASTM D 2774 – Underground Installation of Thermoplastic Pressure Piping.

HH. ASTM F 1417 – Installation Acceptance of Plastic Gravity Sewer Lines Using Low–Pressure Air.

II. ANSI/AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 inches, for Water Transmission and Distribution.

JJ. ANSI/AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 inches, for Water Transmission and Distribution.

1.5 MEASUREMENT AND PAYMENT

A. Measurement – Items listed in the proposal shall be considered as sufficient to complete work in accordance with plans and specifications. Any portion of work not listed in the bid form shall be deemed to be a part of item it is associated with and shall be included in costs of unit shown on bid form. Payment for unit shown on the bid form shall be considered satisfactory to cover cost of all labor, material, equipment, and performance of all operations necessary to complete work in place. The unit of measurement shall be unit shown on bid form. Payment shall be based upon the actual quantity multiplied by unit prices. Where work is to be performed at a lump sum price, the lump sum shall include all operations and elements necessary to complete work.

B. Payment – Payment for pipe, fittings, valves, and other equipment will be paid based on the lump sum as tabularized in the bid form.

1.6 QUALITY ASSURANCE

A. Contractor will furnish the Engineer and Owner a description of all material before ordering. Engineer will review the Contractor's submittals and provide in writing an acceptance or rejection of material.

B. Where ductile iron pipe is indicated on the plans, or required by Engineer, it shall be used.

C. Material and equipment shall be the standard products of a manufacturer who has manufactured them for a minimum of two years and provides published data on their quality and performance.

D. A subcontractor for any part of the work must have experience on similar work, and if required, furnish Engineer with a list of projects and Owners or Engineers who are familiar with its competence.

E. If Contractor wishes to furnish devices, equipment, structures, and systems not designed by Engineer, these items shall be designed by either a Professional Engineer registered in the project state or by someone Engineer accepts as qualified. If required, complete design calculations and assumptions shall be furnished to the Engineer or Owner before acceptance.

F. Testing shall be by a testing laboratory which operates in accordance to ASTM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regularly scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

G. Infiltration, line and grade of sewer, pump performance, and hydrostatic tests on force mains shall be made by Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

1.7 PRODUCT DELIVERY, STORAGE & HANDLING

A. Material shall be unloaded in a manner avoiding damage and shall be stored where it will be protected and will not be hazardous to traffic. If stored on private property, Contractor shall obtain permission from property owner and shall repair any damage caused by the storage. Material shall be examined before installation. Neither damaged nor deteriorated material shall be used in the work.

1.8 JOB CONDITIONS

A. Installation of the sanitary sewerage system must be coordinated with other work on site. Generally, sanitary sewer pipes will be installed first and shall be backfilled and protected so subsequent excavating and backfilling of other utilities does not disturb them. Contractor shall replace or repair any damaged pipe or structure at no additional expense to the Owner.

1.9 SEQUENCING AND SCHEDULING

A. Contractor shall arrange the work so sections of sewers between manholes are backfilled and tested, lateral sewers connected, pavement replaced, and placed in service as soon as reasonable after installation.

1.10 ALTERNATIVES

1.11 GUARANTEE

A. Contractor shall guarantee quality of materials, equipment, and workmanship for 12 months after acceptance of the completed Project. Defects discovered during this period shall be repaired by Contractor at no cost to the Owner.

1.12 EXISTING UTILITIES

A. All known utility facilities are shown schematically on the construction drawings, and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities not shown will not relieve the Contractor of responsibility under this requirement. "Existing Utilities Facilities" means any utility existing on the project in its original, relocated, or newly installed position. Contractor will be held responsible for cost of repairs to damaged underground facilities, even when such facilities are not shown on the drawings.

B. The Contractor shall call for underground utility locations before starting work. Underground utilities location services can be contracted at 1-800-282-7411 or 811.

1.13 TESTING

A. Laboratory tests for moisture density relationship for fill materials shall be in accordance with ASTM D 1557, (Modified Proctor).

B. In place density tests in accordance with ASTM D 6938.

C. Testing laboratory shall operate in accordance with ASTM D 3740 and E 329 and be acceptable to the Engineer.

D. Testing laboratory and Project Engineer/Project Representative shall be given a minimum of 48–hours notice prior to taking any tests.

E. Testing shall be Contractor's responsibility and shall be performed at the Contractor's expense by a commercial testing laboratory operating in accordance with subparagraph C above.

F. Test results shall be furnished to the Engineer prior to continuing with associated or subsequent work.

PART 2 – PRODUCTS

Materials used in the work shall be those named in Bid Form. In multiple type bids, selection of material types will be at the opinion of Owner. Materials and products used in work shall conform to one of the following:

2.1 SEWER PIPE

A. PVC Pipe – Shall be polyvinyl chloride plastic (PVC) and shall meet all requirements of ASTM D 3034 SDR 26, except for depths less than 3 feet where ductile iron pipe must be installed. All pipe shall be suitable for use as a gravity sewer conduit. Provisions must be made for contraction and expansion at each joint with a rubber gasket. Pipe sizes and dimensions shall be as shown below. All pipe shall be green or white in color with factory marked homing lines. Fittings shall meet the same specification requirements as pipe.

Nom. Size	Outside Diameter		Min. Wall Thickness
	Average	Tolerance	SDR–26
4	4.215	± 0.009	.162
6	6.275	± 0.011	.241
8	8.400	± 0.012	.323
10	10.500	± 0.015	.404
12	12.500	± 0.018	.481

Tests on PVC Pipe – Pipe shall be designed to pass all tests at 73 ° F. (3° F.).

B. Ductile Iron – Shall conform to ANSI A 21.50 (AWWA C 150), ANSI A 21.51 (AWWA C 151) and ASTM A 746. All pipe shall be Pressure Class 350 unless otherwise noted. All ductile iron pipes and fittings shall be bituminous coated on the outside and lined with Protecto 401 Ceramic Epoxy or equivalent on inside.

1. Coating on the outside shall be an asphaltic coating approximately 1 mil thick. Finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to sun, and shall be strongly adherent to the iron.

2. Protecto 401 Ceramic Epoxy or equivalent interior lining shall conform to ASTM E 96, ASTM D 714, ASTM D 2794 and ASTM G 53. Interior of the pipe shall receive 40 mils nominal dry film thickness of epoxy. Lining application, inspection, certification, handling, and surface preparation of area to receive the protective coating shall be in accordance with manufacturer's specifications and requirements.

2.2 JOINTS – GRAVITY SYSTEM

A. Joints for Ductile Iron Pipe – Shall be slip–on rubber equivalent to "Fastite," "All–tite," or "Tyton."

B. Joints for PVC Pipe – Shall be integral wall bell and spigot with a rubber ring gasket. Joints shall conform to ASTM D 3212 and gaskets to ASTM F 477.

2.3 FORCE MAIN

A. P.V.C. – All pipe shall be green in color with factory marked homing lines. Pipe with diameter less than 4 inches shall conform to all requirements of ASTM D 2241, SDR 26, Class 160. Pipe 4 inches through 12 inches shall conform to all requirements of AWWA C900, DR 25, Pressure Class of 165 p.s.i. Pipe 14 inches through 18–inches shall conform to all requirements of AWWA C905 with C1 outside diameter, DR 25, with a pressure rating of 165 p.s.i. Joints shall be in accordance with ASTM D 3139.

B. Ductile Iron pipe shall be in accordance with Paragraph 2.1–B and conform to ASTM A 377. Push–on–Joints shall be slip–on rubber equivalent to "Fastite," "All–tite," or "Tyton." Flanged joints shall conform to AWWA C 115. Gaskets shall conform to AWWA C 111.

C. Thrust blocking shall be sized as detailed on the construction drawings of 3,000 p.s.i. concrete. Blocking shall be provided at all bends deflecting 11–1/4 degrees or more and bear directly against the undisturbed trench wall.

D. Restrained Joints – Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push–on type joints equivalent to "Lok–Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure equal to the item restrained with a minimum safety factor of 2:1. Joints shall be in accordance with the applicable portions of AWWA C–111. Manufacturer of joints shall furnish certification, witnessed by an independent laboratory, stating joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

2.4 CASING

A. Casing pipe shall be steel conforming to ASTM A 139, yield point of 35,000 p.s.i., of the diameter shown on drawings at each crossing. The minimum wall thickness shall be 0.25 inches.

2.5 CASING SPACERS

A. Casing spacers shall be bolt on style with a shell made in two sections of a minimum 14 gauge T–304 Stainless Steel. Connecting flanges shall be ribbed for extra strength. The shell shall be lined with a PVC liner. All nuts and bolts shall be T–304 Stainless Steel. Runners shall be made of Ultra High Molecular Weight Polymer with inherently high abrasion resistance and a low coefficient of friction. The combined height of supports and runners shall keep carrier pipe a minimum of 0.75–inches from casing pipe at all times. Casing Spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, or accepted equivalent.

2.6 MANHOLES

A. Masonry – Shall be new whole brick of good quality laid in masonry mortar or cement mortar made of one part Portland cement and two parts clean sharp sand. Every brick shall be fully bedded in mortar. Manholes shall conform to locations and details shown on the plans.

B. Precast Concrete – Shall be reinforced concrete constructed in accordance with ASTM C 478 and details shown on the plans "Precast Concrete Manholes." Coarse aggregate shall be granite stone. The joints shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O–Ring or equivalent to Type A or B "Tylox" conforming to ASTM C 443. Mastic shall be equivalent to "Ram–nek" with primer. Primer shall be applied to all contact surfaces of manhole joint at the factory in accordance with manufacturer's instructions.

C. Frames and Covers – Shall be cast iron equivalent to the following:

Neenah Foundry Co. R-1668 Type "C" Lid

D. Manhole Steps – Shall be equivalent to M.A. Industries, Type PS–1 or PS–2–PF. Steps shall be installed at the manhole factory and in accordance with recommendations of step manufacturer. Manholes will <u>not</u> be acceptable if steps are not installed accordingly.

E. Pipe Connections – Shall have flexible watertight joints at sewer main point of entry into the manhole. The joint shall be an EPDM or polyisoprene sleeve equivalent to "Kor–N–Seal."

F. Coatings – New manholes shall have all interior surfaces coated with a factory applied acrylic polymer–base coating and sealant. The coating shall be ConSeal CS–55 manufactured by Concrete Sealants, New Carlisle, Ohio or an accepted equivalent. The coating shall be applied in three coats to achieve a total dry film thickness of at least 3.5 mils in accordance with manufacturer's recommendations. Surfaces shall be cleaned of all dust, form oils, curing compounds and other foreign matter prior to the coating application.

New or existing manholes requiring a force main tie–in and the next downstream manhole shall be coated with 125 wet film mils of Raven 405 ultra high build epoxy or an accepted equivalent. The interior surfaces shall be cleaned and prepared according to manufacturer's recommendations.

2.7 TEES

A. Gravity sewer tees shall be four or six inches and same diameter as the run of pipe. They shall be of same material as the sewer main.

2.8 LATERALS

A. Shall be Ductile Iron Pipe conforming to paragraph 2.1–B, with push–on joints or Polyvinyl Chloride pipe with bells and rubber gaskets for jointing, conforming, to Paragraph 2.1–A, PVC Pipe.

2.9 STONE BACKFILL

A. Shall be graded crushed granite with the following gradation:

Square Opening Size	Percent Passing
1 inch	100%
3/4 inch	90 to 100%
3/8 inch	0 to 65%
No. 4	0 to 25%

2.10 SAND BACKFILL

A. Shall be clean sand free from clay and organic material. Not more than 10% shall pass the No. 100 sieve.

2.11 BORROW

A. Where it is determined sufficient suitable material is not available from the site to satisfactorily backfill pipe to at least two feet above top of pipe, Contractor shall furnish suitable sandy borrow material to accomplish requirements. Material shall not have more than 60% passing the No. 100 sieve, nor more than 20% passing a No. 200 sieve.

2.12 AIR RELEASE VALVE

A. Shall be designed for sewage service. The valve shall be constructed of a cast iron body, stainless steel or bronze trim, and stainless steel float. The inlet shall be 2 inches, 5/16 inch orifice, and a venting capacity of 35 c.f.f.a.m. The working pressure shall be 0 to 50 p.s.i. It shall conform to detail shown on the drawings.

2.13 METAL DETECTOR TAPE

A. Will be installed above all pipe. Tape shall consist of 0.35 mils thick solid foil core encased in a protective plastic jacket resistant to alkalis, acids, and other destructive elements found in the soil. The lamination bond shall be strong enough so layers cannot be separated by hand. Total composite thickness shall be 5.0 mils. Foil core to be visible from unprinted side to ensure continuity. The tape shall have a minimum 3 inch width and a tensile strength of 35 lbs. per inch.

A continuous warning message indicating "sewer line" repeated every 16 inches to 36 inches shall be imprinted on the tape surface. Tape shall contain an opaque color concentrate designating color code appropriate to the line being buried (Sewer Line – Green).

2.14 TRACING WIRE

A. Will be used over all force main, sanitary sewer, and service lateral lines. The wire will be #12 gauge insulated single strand copper wire.

2.15 SUBMERSIBLE SEWAGE PUMPING STATION

A. Shall be dual submersible pumps installed in a concrete wet well. Pumps shall be equivalent to Flygt or ABS conforming to characteristics shown on the drawings.

B. Wet Well – Shall be precast reinforced concrete sections. The product design, performance, materials, manufacturing, handling, and installation shall conform to following references and project specifications:

<u>ACI 318</u> – Building Code Requirements for Reinforced Concrete

<u>ASTM C 39</u> – Compressive Strength of Cylindrical Concrete Specimens

<u>ASTM C–478</u> – Precast Reinforced Concrete Manhole Sections

<u>ASTM C 890</u> – Minimal Structural Design Loading for Precast Concrete Water and Wastewater Structures

<u>ASTM C 891</u> – Installation of Underground Precast Concrete Utility Structures

<u>ASTM C 913</u> – Precast Concrete Water and Wastewater Structures

Contractor or supplier shall provide for design of the precast structure. Each section of the structure shall be designed and manufactured for its individual depth, loading conditions (lateral, surcharge and hydrostatic), and opening requirements. All concrete in the precast structure shall have a <u>minimum</u> compressive strength of 4,500 p.s.i. after 28 days. Reinforcing steel shall comply with ASTM A 615 Grade 60 (min. fy = 60,000 p.s.i.). Bar bending and placement shall comply with the ACI latest standards.

Precast structure manufacturer shall have necessary equipment and facilities for proper manufacture of the sections and to perform compressive strength tests on concrete tests specimens. Test cylinders shall be made for each structure and test conducted in accordance with ASTM C 39, except compressive strength shall be equal to or greater than design of the concrete. Structure design computations, concrete mix design, and test reports certifying design strength has been achieved at the <u>28 day</u> break shall be submitted to Engineer. Design of structure shall be performed by a Professional Engineer registered in the state of installation at Contractor's expense. The design parameters for a precast structure shall include:

Lateral load based on a water table at the surface using equivalent fluid pressure of 80 p.c.f. from surface grade down and a vehicle wheel load designation of HS20–44. Design live load for the top slab shall be 300 p.s.f. The precast concrete sections shall have a minimum wall thickness of 6 inches and minimum top and bottom slab thicknesses of 8 inches. Actual thicknesses greater than minimum shall be as required by the loading conditions.

Access hatches in the top slab of wet–well structure shall be for clear opening dimensions indicated and have a load capacity of 300 p.s.f. The material shall be Aluminum Alloy 6063–T5 and T6, minimum 1/4 inch thick plate, flush–type lock with inside spoon handle. The frame shall be complete with hinged and hasp–equipped cover, upper guide holders, chain holders and cable holder. Chain and cable holders shall be stainless steel or aluminum. Frame shall be securely mounted above the pumps. The hatch covers shall be torsion–bar loaded for ease of lifting and shall have a safety–locking handle in open position.

Contractor shall furnish and install guide bars for each pump to permit raising and lowering the pump. Guide bars shall be stainless steel and of adequate length and strength to extend from lower guide holders on the pump discharge connection to upper guide holder mounted on access frame.

The wet well shall be provided with sleeves, 24 inches below finished grade, for access of power and control conduits. The sleeves shall be of proper size and number to accommodate all necessary power and control conduits.

All interior concrete surfaces shall have either a minimum 125 mils coating of Raven 405, factory installed 5 mm Agru Sure Grip HDPE Liner, or an accepted equivalent. When using the liner, all seams shall be sealed with welded HDPE material and all penetrations shall be sealed with a welded HDPE boot.

The structure manufacturer shall prepare and submit six sets of shop drawings showing wall and slab thicknesses, structural reinforcing and opening locations. The manufacturer shall also provide design analyses and calculations to show all sections have been designed for burial depths shown on construction drawings as well as stresses incurred during transport, handling and installation. Calculations and analyses must be performed and sealed by a Licensed Professional Engineer from the state project is located and submitted for review. All shop drawings and design calculations shall be submitted to the Contractor for review. Contractor shall forward these documents to the Engineer. Such documents shall bear the stamp or written statement of Contractor indicating Contractor's review for completeness and receipt. Contractor shall be responsible for the accuracy of shop drawings and for their conformity to plans and specifications. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by Contract Documents.

C. Pump Design – Pumps shall be capable of handling raw, unscreened sewage with the capacity to pass 3 inch diameter spheres. Pumping units shall be automatically connected to discharge piping when lowered into place on the discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastening to be removed for this purpose, and no need for personnel to enter wet well. Each pump shall be fitted with a stainless steel chain of adequate strength and length to permit raising the pump for inspection and removal.

D. Pump Construction – The pump(s) shall be designed to pump sewage, storm water, heavy sludge and other fibrous materials without injurious damage during operation. The lifting cover, stator housing and volute casing shall be of gray iron construction with all nuts, bolts, washers and other fastening devices coming into contact with sewage, constructed of stainless steel and protected by primer coat and a coat of rubber–asphalt or epoxy paint. The impeller shall be hard alloy gray iron construction, dynamically balanced, double shrouded, non–clogging design with a long thoroughfare and no acute angles.

The pump motor shall be of Class F Insulation, NEMA B design, watertight and positively oil cooled, filled with a transformer oil, equivalent to BP JS–HA, Shell Diala D, or housed in an air–filled watertight chamber. The pump motor shall be guaranteed to run in a totally, partially or non–submerged condition continuously for a period of 24 hours without injurious damages. Water cooled pumps shall not be considered equal. Before final acceptance, a field running test at job site demonstrating the ability to operate continuously for 24 hours under a non–submerged condition, shall be performed for all pumps being supplied, if required. The pump shall be provided with a tandem double mechanical seal running in an oil bath. The seals shall be of lapped tungsten carbide and welded to stainless steel retainers and held in contact by separate springs. Conventional double mechanical seals with a spring assembly between the rotating faces, requiring constant differential pressure to effect sealing and subject to penetration and opening by pumping forces shall not be considered equal to tandem seal specified and required. The pump shaft shall be of stainless steel and supported by a double row inboard bearing for axial thrust and a single row outboard bearing for radial thrust. The impeller shall be connected to a short sturdy shaft in order to minimize shaft deflection. Shaft shall not extend more than 2–1/2 times its diameter below the nearest support bearing.

The pump cable shall be of proper length to reach from pumps in wet well to control panel without any splices. Cable shall be the "SO" or hypalon jacketed SPC type and in compliance with industry standards for loads, resistance against sewage and of stranded construction. Cable shall enter the pump through a heavy duty entry assembly, which shall be provided with an internal grommet assembly to protect against leakage once secured and must have a strain relief assembly as part of standard construction. Power cable shall connect to a terminal board separating incoming service from pump motor, where if leakage occurs, terminal board will short out and not cause damage to the motor.

Each pump shall be supplied with a universal coupling which bolts to pump discharge flange and shall accept the discharge elbow provided by pump manufacturer. Seal of the pump at discharge flange shall be accomplished by a single downward linear motion of pump with entire weight of pump guided to and pressing against discharge connection. No part of pump shall bear directly on the sump floor and no rotary motion of pump shall be required for sealing. Sealing at the discharge shall be designed to insure a positive leakproof system and for ease of removal. Pump shall be guaranteed not to leak at the discharge flange.

E. Pump Test – Pump manufacturer shall perform following tests on each pump before shipment from the factory:

1. Megger the pump for insulation breaks or moisture.

2. Prior to submergence, the pump shall be run dry and be checked for correct rotation.

3. Pump shall be run for 30 minutes in a submerged condition.

4. Pump shall be removed from test tank, meggered immediately for moisture; oil plugs removed for checking of upper seal and possible water intrusion of stator housing.

5. A written certified test report giving above information shall be supplied with each pump at the time of shipment.

6. All pump cable ends will then be fitted with a rubber shrink fit boot to protect cable prior to electrical installation.

F. Pump Controls – To synchronize the operation of pumps with variations of sewage level in wet well, Contractor shall provide a liquid level sensor system equivalent to ITT Flygt MultiTrode. The system shall utilize a single piece multi–sensored probe to determine pump–on, lag pump on, pump–off, and high–level alarm conditions. Probe shall be constructed from PVC 1.25 inch tubing with molded sensor units at regular intervals along the probe. Each sensor unit will be PVC injected to prohibit ingress of moisture, and the sensor material shall be Avesta SMO 254 stainless steel.

Mounting – Probe will be mounted in a turbulent area of wet well, suspended on its own cable and connected to a 0.23 inch stainless steel hook which will be hooked to a 1.18 inch stainless steel angle containing a polyurethane squeegee pad positioned in the opening into wet well, so probe can be removed without entering wet well. The squeegee will have a 1.18 inch hole and slot, enabling probe to be pulled through and cleaned.

This installation will be in accordance with the manufacturer's instructions.

Probe shall be covered by the manufacturer's two–year warranty.

Probe and Sensors – 10 sensors will be spaced along the length of probe assembly, and each will be individually connected to a correspondingly numbered PVC/PVC 0.03 inch flexible cable.

The molded sensor unit will contain two Avesta sensors mounted on opposing sides of sensor unit. Each Avesta sensor will be 0.94 inches high and no wider than 0.08–inches, and will protrude from surface of the PVC.

The probe shall be pressure injected with an epoxy resin to encapsulate all internal components and connections to form a rigid, homogenous unit.

Each sensor unit containing the two Avesta sensors will be rotated 90 degrees to previous sensor unit to eliminate tracking between sensors.

Cable – The cable will be numbered (number and text) along entirety of cable and at intervals not greater than 7.5 inches for identification. This cable will be dark blue in color, with the cores light blue.

Flexible cables shall be capable of supporting the weight of probe and cable, without need for additional support.

The cable shall be secured to top of probe by a synthetic rubber compression fitting.

MTR Relay – The conductance level control relay shall be a Din rail mounted device with supply and activation LEDs, eight programmable activation delays, charge/discharge settable and four sensitivity settings (2k, 4k, 20k, 80k) all easily carried out while installed. A green LED shall be provided on front of relay and shall remain lit while power is connected to the unit. A red LED shall be provided on front of device and shall remain lit while the output relay is active. Each output shall be capable of a five amp resistance load at 250 VAC.

Floats – Furnish one high–level alarm float and one low–level shut off float. The low level float shall be capable of over–riding the Multi Trode Controller.

An alternator shall also be provided to change operation sequence of pumps at the completion of each pumping cycle. Provisions shall also be made for pumps to operate in parallel if level in wet well continues to rise above the "pump–on" cycle. Contractor shall furnish and install one automatic control center, equipped with individual disconnects, across–the–line magnetic starters, 3 phase, overload and phase protection, electrical alternator, automatic transfer to non–operating pump in event of overload in operating pump, overload reset, hand–off–automatic pump operation selector switch, 24 volt control circuit transformer, and terminal board with connections for high–level alarm. All components shall be housed in a NEMA 4X enclosure. Control center shall be installed on a treated timber rack next to the station. Cables provided for pump feeders and pump controls shall be installed in conduit from control center to entrance point in wet well. See detail sketch on construction drawings.

G. Alarm – A high water alarm shall be supplied. A red flashing light shall be supplied in separate NEMA 4X enclosure for mounting at the control box. An audible alarm consisting of a weatherproof bell with automatic reset silencer switch and signal light shall be installed in addition to the flashing red light alarm.

H. Submersible Pump Station Valve Pit – The valve pit shall be precast concrete of dimensions shown on construction drawings. Valve pit shall meet the requirements for precast concrete specified in section 2.15, paragraph B. Each pit shall have a hatch cover. The covers shall be as shown on the construction drawings.

I. Hydrants – Shall be frost–proof with 36 inch bury, 1 inch male outlet, and 1 inch male inlet, with outlet 36 inches above the ground. Water line from the main to hydrant shall be 1 inch diameter, rated for a minimum working pressure of 200 p.s.i.

J. Backflow Preventer – Shall be a 1 inch reduced pressure zone assembly mounted in a plastic meter box. Backflow preventer shall be equivalent to Watts Regulator Model No. 009.

K. Fencing – A new fence shall be installed at pump station site where shown on the drawing and shall be in accordance with Section 32 31 13 – "Chain Link Fences and Gates."

A 3 inch x 5 inch, 7 gauge, stainless steel plate with an emergency phone number shall be furnished and installed at a conspicuous location on the fence or control panel.

L. Access Road – Access road to station shall be as shown on the drawing. Stabilization shall be accomplished by constructing a base using granite crusher run stone aggregate composed of 50% screenings and 50% stone, compacted to 6–inch thickness.

M. Shop Drawings – Contractor shall submit for review by Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements. Model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.

All shop drawings shall be completely checked and marked accordingly with Contractor's stamp prior to submitting drawings to the Engineer for review. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Where shop drawings are "Furnished as Corrected," the reviewer has noticed deficiencies in compliance with contract specifications and drawings. It is understood corrections indicated will be incorporated by Contractor in the final product, operation and maintenance manuals and shop drawings submitted at completion of project. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by contract documents.

N. Pump Warranty – The pump manufacturer shall warrant pumps being supplied to Owner against defects in workmanship and materials for a period of 5–years under normal use, operation, and service. In addition, the manufacturer shall replace certain parts which become defective through normal use and wear on a progressive schedule of cost for a period of 5–years. Parts included are the mechanical seal, impeller pump housing, wear ring, and ball bearings. The warranty shall be in published form and apply to all similar units.

O. Operation and Maintenance Manual – The pump manufacturer shall furnish Owner with a minimum of six manuals for pumps installed.

P. Electrical Service – Service to the pumping station shall be as indicated on the Construction plans and electrical specifications.

Conduits below grade shall be Schedule 40 PVC and above grade shall be rigid galvanized. Conduits shall be sealed to prevent sewer gases entering the control panel. Sealing shall be accomplished by stuffing both ends of the conduit with duct–seal, or other accepted material.

Conductor shall be copper.

The neutral conductor of each service shall be grounded to a ground rod system. Grounding conductor shall be sized in accordance with Article 250 of the N.E.C. and shall be installed in non–metallic conduit to points of ground connection.

Ground rod system shall consist of three 3/4 inch x 10 foot copper weld ground rods. Ground rods shall be installed 3 feet apart with top of rods 12 inches below grade and shall be interconnected with a bare copper grounding conductor. Connections to ground rods shall be with chemical weld connectors.

1. Running Time Meters – Shall be installed for measuring the elapsed running time for each pump. Meters shall be installed on the face of control panel with counter visible when door or panel is opened. One meter shall be provided for each starter, and shall be connected to operate simultaneously with the starter it is monitoring. Meters shall be non–reset type, hermetically sealed, 115 volts, 60 hertz, with a five digit counter registering 1/10 hour and a total range of 99,999–hours.

2.16 CHECK VALVES

A. Shall be designed for sewage service. The valve shall be cast iron and bronze fitted. The valve shall be a spring and lever type with neoprene seat and O–Ring seals on a stainless steel valve pin, for pipes 3 inches and larger in diameter. For check valves smaller than 3 inches, the valve shall be a fully ported 150 p.s.i. rated ball check valve with a corrosion resistant phenolic base and a rubber seat. Check valve shall be of full waterway design for quiet operation and with a flow area through the valve equal to or exceeding flow area of pipe to which it is installed.

2.17 GATE VALVES

A. Two Inches and Larger – Shall be cast iron or ductile iron body, bronze mounted, double disc or resilient wedge design, with non–rising stems, conforming to AWWA C 500, C 509, or C 515. Valves shall have ends to match the pipe to which they are attached. Attachment to plastic pipe shall be made by special adapters. Valves shall have a working pressure of 200 p.s.i. and be tested at 400 p.s.i.

Valves shall be furnished with "O" ring packing. One "O" ring shall be located above the thrust collar and one below. Thrust collar shall be permanently lubricated and have an anti–friction washer on top of the thrust collar.

B. Smaller Than 2 inches – Shall be all brass, ball valve type. The pressure rating shall be 175 p.s.i.

C. Valve Boxes – Underground valves shall be installed in acceptable valve boxes. Valve boxes shall have a suitable base which does not damage valve or pipe, and shaft extension sections to cover and protect the valve and permit easy access and operation. The box, cover, and extensions shall be cast or ductile iron having a crushing strength of 1,500 pounds per linear foot.

2.18 PLUG VALVES

A. Shall be fully ported and of the same diameter as pipes to which they are attached. They shall have semi–steel bodies, all metal plugs, stainless steel bearings, and be equivalent to DeZurik Series 100 eccentric valves, lever operated. All valves 6 inches and larger shall be equipped with gear actuator and handwheel.

2.19 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. Engineer will review all products before they are ordered by Contractor.

PART 3 – EXECUTION

3.1 CONSTRUCTION OBSERVATION

A. The line, grade, deflection, and infiltration of sewers and pump station operation shall be tested by Contractor under direction of Engineer. Engineer or Project Representative will have the right to require any portion of work to be completed in their presence. If work is covered up after such instruction, it shall be exposed by Contractor for observation. However, if Contractor notifies Engineer such work is scheduled and Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed and materials furnished shall be subject for eview by the Engineer or Project Representative. All improper work shall be reconstructed. All materials not conforming to requirements of specification shall be removed from the work upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

It will also be required by Contractor to keep <u>accurate</u>, legible records of the location of all sanitary lines, service laterals, manholes, force mains, valves, bends, and appurtenances. These records will be prepared in accordance with "Record Data and Drawings" paragraph in the Special Conditions. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.2 LOCATION AND GRADE

A. Line and grade of sewers and position of all manholes and other structures are shown on the drawings. Grade line as given on the profile or mentioned in these specifications means invert or inside bottom of pipe and price for trenching shall include trench for depth below this line necessary to lay sewer to this grade, but measurements for payment will be made only to grade line. Master control lines and bench marks have been provided by the Engineer. The Contractor shall be responsible for proper locations and grades of sewers.

3.3 SEWER EXCAVATION

A. Contractor shall perform all excavations of every description and of whatever substance encountered to the depth shown on the plans or specified for all sewers, manholes, and other appurtenances. All excavations shall be properly dewatered before installations are made, by the use of well points, pumping, or other methods accepted by Engineer. Trenches shall be excavated in conformance with the Occupational and Safety Health Administration's (OSHA) Regulations.

Where the character of soil is unsuitable for pipe bedding as determined by Engineer or Geotechnical Consultant, additional excavation will be authorized. Engineer or Geotechnical Consultant shall determine the depth needed for additional bedding and whether material will be sand or stone. The unsuitable material shall be disposed of at Contractor's expense in a proper manner. Bottom of all trenches shall be rounded to conform to bottom of pipe, to afford full bearing on pipe barrel. Excavation in excess of depths and widths required for sewers, manholes, and other structures shall be corrected by pouring subfoundations of 3,000 p.s.i. concrete and half cradle at the Contractor's expense.

B. Trenches shall not be excavated more than 400 feet in advance of pipe laying.

3.4 TRENCH WALL SUPPORT

A. Bracing and Sheeting – The sides of all trenches shall be securely held by stay bracing, or by skeleton or solid sheeting and bracing, as required by soil conditions encountered, to protect adjoining property and for safety. Where shown on drawings or where directed by Engineer, the Contractor must install solid sheeting to protect adjacent property and utilities. Sheeting shall be steel or timber and Contractor shall submit design data, including the section modulus of members and arrangement for bracing at various depths, to Engineer for review before installing sheeting. It shall penetrate at least 3–feet below the pipe invert. Contractor shall ensure support of pipe and its embedment is maintained throughout installation and ensure sheeting is sufficiently tight to prevent washing out of the trench wall from behind sheeting.

B. Sheeting Removal – Sheeting shall be removed in units and only when backfilling elevation has reached the level necessary to protect pipe, adjoining property, personnel, and utilities. Removal of sheeting or shoring shall be accomplished in a manner to preclude loss of foundation support and embedment materials. Fill voids left on removal of sheeting or shoring and compact all materials to required densities.

C. Movable Trench Wall Supports – Do not disturb installed pipe and its embedment when using movable trench boxes and shields. Movable supports should not be used below top of pipe zone unless acceptable methods are used for maintaining the integrity of embedment material. Before moving supports, place and compact embedment to sufficient depths to ensure protection of the pipe. As supports are moved, finish placing and compacting embedment.

D. When sheeting or shoring cannot be safely removed, it shall be left in place. Sheeting left in place shall be cut off at least 2 feet below the surface. No separate payment shall be made for bracing and sheeting except where shown on drawings or authorized by the Engineer.

3.5 LAYING PIPE

A. All sewer pipe shall be laid upgrade with spigots pointing downgrade and in accordance with ASTM D 2321. The pipe shall be laid in a ditch prepared in accordance with Paragraph 3.3 "Sewer Excavation." When sewer is complete, the interior surface shall conform on bottom accurately to grades and alignment fixed or given by Engineer. Special care shall be taken to provide a firm bedding in good material, select borrow, stone backfill or 3,000 p.s.i. concrete, as authorized, for length of each joint and 1/2 of the circumference. Holes shall be provided to relieve bells from bedding strain, but not so large to allow separation of the bell from barrel by settlement after backfilling. All pipe shall be cleaned out, and left clean. Every third joint shall be filled around immediately after being properly placed.

B. Jointing – Comply with manufacturer's recommendations for assembly of joint components, lubrication, and making joints. When pipe laying is interrupted, secure piping against movement and seal open ends to prevent the entrance of water, mud, or foreign material.

C. Placing and Compacting Pipe Embedment – Place embedment materials by methods which will not disturb or damage the pipe. Work in and tamp haunching material in area between the bedding and underside of pipe before placing and compacting remainder of embedment in pipe zone. Do not permit compaction equipment to contact and damage the pipe. Use compaction equipment and techniques compatible with materials used and location in the trench. Before using heavy compaction or construction equipment directly over the pipe, place sufficient backfill to prevent damage, excessive deflections, or other disturbance of the pipe.

D. Rock or Unyielding Materials in Trench Bottom – If ledge rock, hard pan, shale, or other unyielding material, cobbles, rubble, debris, boulders, or stones larger than 1.5–inches are encountered in the trench bottom, excavate a minimum depth of 6–inches below pipe bottom and replace with proper embedment material.

E. Vertical Risers – Provide support for vertical risers as commonly found at service connections, cleanouts, and drop manholes to preclude vertical or lateral movement. Prevent the direct transfer of thrust due to surface loads and settlement, and ensure adequate support at points of connection to main lines.

F. Exposing Pipe for Making Service Line Connections – When excavating for a service line connection, excavate material from above the top of main line before removing material from sides of pipe. Materials and density of service line embedment shall conform to specifications for the main line.

G. Manhole Connections – Use flexible water stops, resilient connectors, or other flexible systems acceptable to the Engineer making watertight connections to manholes and other structures.

H. Jacking and Boring – Steel casing of diameter shown on the plans shall be jacked and bored in location indicated. Joints between sections of the steel casing shall be of a continuous weld made by a certified welder. Jacking and boring shall be in accordance with Georgia Department of Transportation Specifications. Carrier pipe shall be installed as shown on the detail. After carrier pipe has been installed, ends of the casing shall be sealed using a runner enclosure and stainless steel straps or brick and mortar (as indicated on drawings).

Where work involves a highway, a Resident Engineer of the State Department of Transportation shall be notified 3 days before crossing is started. Where work involves a railroad, the work shall conform to requirements of AREA specifications. Division Superintendent of the Railroad shall be notified 3 days prior to beginning work. Before commencing work within the right–of–way of railroads or highways, Contractor shall verify Owner has obtained required permits.

3.6 SEPARATION BETWEEN WATER & SANITARY SEWER

A. Parallel Installation:

1. Water mains shall be laid at least 10 feet horizontally from any existing or proposed sanitary sewer, storm sewer, or sewer manhole. The distance shall be measured edge–to–edge.

2. When conditions prevent a horizontal separation of 10 feet, water main may be laid closer to a sewer (on a case–by–case basis) provided water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation where bottom of water main is at least 18 inches above top of sewer. It is advised the sewer be constructed of materials and with joints equivalent to water main standards of construction and be pressure tested to assure water–tightness prior to backfilling.

B. Crossing:

1. Water mains crossing house sewers, storm sewers, or sanitary sewers shall be laid to provide a separation of at least 18 inches between the bottom of water main and top of sewer. At crossings, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.

2. When conditions prevent a vertical separation of 18 inches, the sewer passing over or under water mains shall be constructed of materials and with joints equivalent to water main standards of construction and shall be pressure tested to assure water–tightness prior to backfilling.

3. When water mains cross under sewers, additional measures shall be taken by providing:

   a. a vertical separation of at least 18 inches between bottom of the sewer and top of water main;

   b. adequate structural support for sewers to prevent excessive deflection of joints settling on and breaking the water mains;

   c. length of water pipe be centered at the point of crossing so joints will be equidistant and as far as possible from sewer; and

d. both sewer and water main shall be constructed of water pipe and subjected to hydrostatic tests, as prescribed in this document. Encasement of the water pipe in concrete shall also be considered.

3.7 BACKFILLING

A. All trenches and excavation shall be backfilled immediately after pipes are laid therein, unless other protection of the pipe line is directed. Backfilling material shall be selected and deposited with special reference to the future safety of pipes. Except where special methods of bedding and tamping are provided for, clean earth or sand shall be solidly tamped about pipe up to a level at least 2 feet above top of pipes, and shall be carefully deposited to uniform layers, each layer solidly tamped or rammed with proper tools to not injure or disturb the pipeline. Remainder of the trench backfilling shall be carried on simultaneously on both sides of pipe in such a manner preventing injurious side pressure. The material used shall be selected from excavated material anywhere on site if any of this material is suitable. Backfill material shall be clean and free of rock, organic and other deleterious matter.

Under traffic areas, the top 24 inches of backfill material shall be compacted to a density of not less than 98% of maximum laboratory density at optimum moisture. Below the 24 inch line and to and including area around pipe, density shall not be less than 95% of maximum laboratory density at optimum moisture. In non–traffic areas, the backfill material shall be compacted to a density of not less than 90% of maximum laboratory density at optimum moisture unless otherwise accepted by Engineer. Compaction tests shall be conducted in accordance with ASTM D 6938 by an independent testing laboratory. Tests are to be taken at the direction of Engineer.

Whenever trenches have not been properly backfilled, or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the ground surface. Backfilling shall be carefully performed, and original surface restored to the full satisfaction of Engineer immediately after installation.

Where thermoplastic (PVC) pipe is installed, Contractor shall take precautions in accordance with ASTM D 2321, during backfilling operations so not to create excessive side pressures, or vertical or horizontal deflection of the pipe nor impair flow capacity.

3.8 MANHOLES

A. Manholes shall be constructed where shown on the drawings or where directed by Engineer. The channel in bottom of manholes shall be smooth and properly rounded. Special care must be exercised in laying the channel and adjacent pipes to grade. Manhole top elevations shall be greater than or equal to the 50 year flood elevation, unless watertight covers are provided. Tops of manholes outside of roads shall be built to grades 1–inch above ground surface in developed areas and 6 inches above ground surface in undeveloped areas unless otherwise shown on the plans. Manholes in roads shall be built to grades designated by the Engineer. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured tongue or groove; or cracked walls will be subject to rejection by Engineer for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection.

No leaks in any manhole will be acceptable. All repairs made from inside the manhole shall be made with mortar composed of one part Portland cement and two parts clean sand. The mixing liquid shall be straight bonding agent equivalent to "Acryl 60."

3.9 STONE BEDDING

A. Where, in the Engineer's or Geotechnical Consultant's opinion, subgrade of pipe trench is unsuitable material, Contractor shall remove unsuitable material to a depth determined by Engineer or Geotechnical Consultant and furnish and place stone backfill in trench to stabilize subgrade. Presence of water does not necessarily mean stone backfill is required. If well points or other types of dewatering will remove the water, Contractor shall be required to completely dewater trench in lieu of stone backfill. Stone bedding will be limited to areas where well pointing and other conventional methods of dewatering will not produce a dry bottom. Stone shall be placed 4 feet wider than the outside diameter of pipe. The pipe shall be carefully bedded in stone as specified, or in accordance with manufacturer's recommendations.

3.10 SAND BEDDING

A. Where, in the Engineer's or Geotechnical Consultant's opinion, character of soil is unsuitable for pipe bedding, even though dewatered, additional depth of excavation as determined by Engineer or Geotechnical Consultant shall be made and replaced with clean sand furnished by Contractor.

3.11 DEFLECTION

A. It is the Contractor's responsibility to assure backfill is sufficient to limit pipe deflection to no more than 5%. When flexible pipe is used, a deflection test shall be made by Contractor on the entire length of installed pipeline, not less than 30–days after completion of all backfill and placement of any fill. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95% of the inside pipe diameter. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of 70,000 p.s.i. or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on opposite end of shaft shall produce compression throughout remote end of ball, cylinder, or circular section. Circular sections shall be spaced so distance from the external faces of front and back sections shall equal or exceed diameter of circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through by hand or by being flushed through with water, shall be cause for rejection of individual run. When a deflection device is used for the test in lieu of a ball, cylinder, or circular sections described, such device shall be acceptable to Engineer prior to use. Device shall be sensitive to 1.0% of diameter of pipe being measured and shall be accurate to 1.0% of indicated dimension. Installed pipe showing deflections greater than 5% of the normal diameter of pipe shall be retested by a run from opposite direction. If retest also fails, the suspect pipe shall be repaired or replaced at no cost to Owner.

3.12 LEAKAGE

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons/day/inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is 2 feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least 2 feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be re–established. The amount of water required to maintain this water level during a 2 hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of 2 hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches – 2.40 gallons

3.13 CLEANING AND ACCEPTANCE

A. Before acceptance of sewer system, it shall be tested and cleaned to the satisfaction of Engineer. Where any obstruction is met, Contractor will be required to clean sewers by means of rod and swabs or other instruments. The pipe line shall be straight and show a uniform grade between manholes. The Engineer shall check lines by lamping or other methods to determine final acceptance.

3.14 CLOSING PIPE

A. When work or pipe installation is suspended, either for the night or at other times, end of sewer must be closed with a tight cover. Contractor will be held responsible for keeping the sewer free from obstruction.

3.15 PARTIAL ACCEPTANCE OF THE WORK

A. Owner reserves right to accept and use any part of the work. Engineer shall have power to direct on what line the Contractor shall work and order thereof.

3.16 GRASSING

A. Grassing of areas disturbed during construction shall be in accordance with Section 32 92 00 – "Turf and Grasses."

3.17 RECORD DATA

A. It will be required of the Contractor to keep accurate, legible records, locating all sewers, force mains, tees, and laterals. These records will be made available to Engineer before final review for incorporation into the Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.18 REMOVE AND REPLACE PAVEMENT

A. Pavement shall only be removed after prior written authorization by the Owner. Pavement removed and replaced shall be constructed in accordance with latest specifications of the State Department of Transportation. Traffic shall be maintained and controlled per State Department of Transportation regulations.

3.19 METALLIC DETECTOR TAPE

A. Contractor shall place metallic detector tape, suitably coded, directly over all installed pipes at a depth of 18 inches below the finished surface.

3.20 TRACING WIRE

A. Tracing wire will be installed on all force mains, sanitary sewer, and service laterals directly on top of the pipe. Wire shall be secured to the pipe with tape or other acceptable methods at spacings of no more than 36-inches apart. Where sections of wire are jointed together, the wire insulation shall be stripped so bare wires can be wrapped with a rubberized insulation tape. The insulated wire must maintain electrical continuity. This tracing wire system shall be checked and tested by the Contractor, in the presence of Engineer or Owner prior to acceptance of force mains, sanitary sewers, and service laterals. All equipment, meters, detectors, etc., needed for testing shall be furnished by the Contractor.

3.20 CONNECT SEWERS TO EXISTING STRUCTURES

A. Contractor shall connect the system to existing structures where indicated. For brick structures, a hole not more than 4 inches larger than the outside diameter of new pipe shall be cut neatly in structure, new pipe laid so it is flush with inside face of structure, and annular space around pipe filled with a damp, expanding mortar or grout to make a watertight seal. For precast structures, core proper size hole in structure for pipe being connected, attach flexible sleeve into cored hole and connect new pipe into flexible sleeve with a stainless steel band.

3.21 FIELD QUALITY CONTROL

A. Soil and density tests shall be made by a testing laboratory acceptable to the Engineer. Laboratory tests of the soil shall be made in accordance with ASTM D 1557. In-place density tests shall be made in accordance with ASTM D 6938. Results of the tests shall be furnished to the Engineer.
The minimum number of tests required shall be:

Backfill over sewer in traffic areas..........	1 per 100 linear feet or less for each 4 feet of depth or portion thereof.
Backfill over sewer in non-traffic areas...	1 per 500 linear feet or less for each 6 feet of depth or portion thereof.

3.22 AIR RELEASE VALVE

A. The manhole and installation of valve shall be in accordance with detail on drawings. Prior to deciding on the location of any air release valve, Contractor shall provide Engineer with an accurate profile of installed force main so high points in system can be determined.

3.23 SEWAGE PUMPING STATION

A. The precast sections shall be carefully handled and placed in position undamaged. Spalled areas, cracks, or exposed reinforcing in any section shall be cause for rejection of a section. Damaged elements shall be promptly removed from the job-site.

The structure shall be installed plumb and level by Contractor on a prepared, evenly distributed and level, minimum 12 inch thick crushed-stone bed. Joints between sections shall be sealed with butyl-rubber or neoprene sealant. Asphaltic-based material or similar products shall not be used. The sealant shall be applied in accordance with sealant manufacturer's recommendation. Leakage through joints or around pipes will <u>not</u> be acceptable. Grout used at construction joints and around pipes shall be Five Star brand non-shrink grout or an acceptable equivalent.

Excavation shall be accomplished in a manner as required to protect adjacent property and utilities and for safety. Backfilling shall be accomplished as soon as practicable after the structure has been placed and sealed. Backfilling shall be achieved by placing material in equal lifts (max. 2 feet) and compacting each lift to maintain stability and plumbness of the structure. Backfill material shall be a select granular material with a maximum plasticity index (P.I.) of 12. Compaction shall be accomplished by means of mechanical tamping to 98% of maximum laboratory density at optimum moisture when tested by ASTM D 6938. During backfilling operation and until its completion, the wet well sections shall be maintained in an absolute plumb position. To prevent structure from possibly becoming buoyant in hydrostatic or flooded conditions, Contractor shall take necessary steps to avoid flotation of the structure.

Pumping station site shall be graded to drain to conform to the drawings. The fence, access road, and grassing shall be constructed after site has been graded.

Contractor shall connect to water main with a saddle or tee and lay water line to the hydrant per location on drawings. The hydrant shall be set in a gravel pocket with a 12 inch x 12 inch x 4 inch concrete collar at ground level. Connection shall be disinfected and tested in accordance with AWWA C 651. Water shall not be used until favorable written test results have been furnished to the Engineer.

Drawings indicate the general arrangement and location of electrical equipment, conduit, piping, transformer, and generator. Installation and location of these items shall be coordinated with the pump station operating personnel.

3.24 FORCE MAIN

A. Ductile Iron Force Main shall be installed in accordance with AWWA C 600.

B. PVC Force Main shall be installed in accordance with ASTM D 2774.

3.25 BYPASSING

A. Bypassing of raw wastewater onto the ground or into a receiving stream is prohibited.

B. Bypassing shall be accomplished with pumping equipment sufficient to maintain the flow of wastewater. Contractor shall provide pump, hoses, materials, and labor to operate and maintain the bypassing operation. A backup pump shall also be made available by the Contractor. Bypassing operations shall be reviewed and acceptable to the sewer system operator before being implemented.

END OF SECTION

INDEX TO

SECTION 33 32 20

WASTEWATER PUMP STATIONS

PART 3 – EXECUTION

SECTION 33 32 20

WASTEWATER PUMP STATIONS

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Influent Pump Station.

B. Plant Drain Pump Station.

C. Equalization Tank Pump Station

1.02 RELATED SECTIONS

A. Section 33 32 21 – Flow Diversion (Bypass Pumping).

B. Section 01 75 15 – Pump Station – Start up.

1.03 OPTIONS

A. The specifications describe several materials. The Owner will decide which ones to be used. Where manufacturers and models of equipment are named in the specifications, it is intended these are to describe quality and function required. Contractor may use equipment or materials of other manufacturers provided they are reviewed and accepted by the Engineer, Owner, and Regulatory Agency and Operator as equivalent to those specified.

1.04 REFERENCES (Latest Revision)

A. ASTM D 3034 – Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

B. ANSI/AWWA C 150/A 21.50 – Thickness Design of Ductile Iron Pipe.

C. ANSI/AWWA C 151/A 21.51 – Ductile Iron Pipe, Centrifugally Cast, for Water, or Other Liquids.

D. ASTM A 746 – Ductile Iron Gravity Sewer Pipe.

E. ASTM D 3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

F. ASTM F 477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

G. ASTM D 2241 – Poly (Vinyl Chloride) (PVC) Pressure–Rated Pipe (SDR Series).

H. ASTM D 3139 – Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

I. ASTM C 443 – Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

J. ACI 318 – Building Code Requirements for Structural Concrete.

K. ASTM C 39/C 39M – Compressive Strength of Cylindrical Concrete Specimens.

L. ASTM C 890 – Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.

M. ASTM C 891 – Installation of Underground Precast Concrete Utility Structures.

N. ASTM C 913 – Precast Concrete Water and Wastewater Structures.

O. ASTM A 615/A 615 M – Deformed and Plain Carbon – Steel Bars for Concrete Reinforcement.

P. ASTM D–6938 – In–Place Density and Water Content of Soil and Soil–Aggregate by Nuclear Methods (Shallow Depth).

Q. ASTM D 2794 – Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

R. ASTM E 96 – Water Vapor Transmission of Materials.

S. ASTM G 154 – Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

T. ANSI/AWWA C 111/A 21.11 – Rubber–Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

U. ASTM A 377 – Index of Specifications for Ductile Iron Pressure Pipe.

V. ANSI/AWWA C 600 – Installation of Ductile Iron Water Mains and Their Appurtenances.

W. ANSI/AWWA C115/A21.15 – Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.

X. ANSI/AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches through 12 inches, for Water Transmission and Distribution.

Y. ANSI/AWWA C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 inches, for Water Transmission and Distribution.

1.05 QUALITY ASSURANCE

A. Contractor will furnish the Engineer and Owner a description of all material before ordering. Engineer will review the Contractor's submittals and provide in writing an acceptance or rejection of material.

B. Where ductile iron pipe is indicated on the plans, or required by Engineer, it shall be used.

C. Material and equipment shall be the standard products of a manufacturer who has manufactured them for a minimum of two years and provides published data on their quality and performance.

D. A subcontractor for any part of the work must have experience on similar work, and if required, furnish Engineer with a list of projects and Owners or Engineers who are familiar with its competence.

E. If Contractor wishes to furnish devices, equipment, structures, and systems not designed by Engineer, these items shall be designed by either a Professional Engineer registered in the project state or by someone Engineer accepts as qualified. If required, complete design calculations and assumptions shall be furnished to the Engineer or Owner before acceptance.

F. Testing shall be by a testing laboratory which operates in accordance to ASTM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regularly scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

G. Pump performance, and hydrostatic tests on force mains shall be made by Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

H. Perform work in accordance with the State of Georgia, Georgia Department of Public Health and Georgia Environmental Protection Division minimum standards.

I. Install pumps and their associated mechanical, electrical and control accessories according to manufactures instructions.

J. Infiltration, line, and grade of sewer, pump performance, and hydrostatic tests on force mains shall be made by Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Material shall be unloaded in a manner avoiding damage and shall be stored where it will be protected and will not be hazardous to traffic. If stored on private property, Contractor shall obtain permission from property owner and shall repair any damage caused by the storage. Material shall be examined before air lift pump

B. installation. Neither damaged nor deteriorated material shall be used in the work.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping system from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of complete system.

E. Accept system components on site in manufacturer's original containers or configuration. Inspect for damage.

F. Store sensitive materials for field assembly in dry area in original shipping containers.

G. Repair damage to wet well and other infrastructure according to manufacturer's instructions.

1.07 JOB CONDITIONS

A. Installation of the improvements must be coordinated with ongoing operations.

B. Contractor shall replace or repair any damaged pipe or structure at no additional expense to the Owner.

C. Installation of the sanitary sewerage system must be coordinated with other work on site. Generally, sanitary sewer pipes will be installed first and shall be backfilled and protected so subsequent excavating and backfilling of other utilities does not disturb them. Contractor shall replace or repair any damaged pipe or structure at no additional expense to the Owner.

1.08 ALTERNATIVES

A. The intention of these specifications is to produce the best system for the Owner. If the Contractor suggests alternate material, equipment or procedures will improve results at no additional cost, Engineer and Owner will examine suggestion, and if accepted, it may be used. The basis upon which acceptance of an alternate will be given is its value to the Owner, and not for Contractor's convenience.

1.09 GUARANTEE

A. Contractor shall guarantee quality of materials, equipment, and workmanship for 12 months after acceptance of the completed Project. Defects discovered during this period shall be repaired by Contractor at no cost to the Owner.

1.10 PRE–INSTALLATION MEETINGS

A. Section 01 31 00 – Administrative Requirements: Pre–installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.11 PERFORMANCE REQUIREMENTS

A. Operation:

1. Provide 2 floats and one Ultrasonic Level transmitter approved by the Engineer. Set elevations in accordance with Drawings or as directed by Engineer. Set pumps to automatically switch operations from one pump to another after shutting off each pumping cycle.

B. Sound, Vibration, and Thermal Control – Dampen or suppress noise, absorb vibration, accommodate thermal expansion and stresses, and adjust or correct for misalignment in piping systems.

PART 2 – PRODUCTS

Materials and products used shall conform to one of the following and shall be as approved by the Engineer:

2.01 SEWER PIPE

A. PVC Pipe – Shall be polyvinyl chloride plastic (PVC) and shall meet all requirements of ASTM D 3034 SDR 26, except for depths less than three feet where ductile iron pipe must be installed. All pipe shall be suitable for use as a gravity sewer conduit. Provisions must be made for contraction and expansion at each joint with a rubber gasket. Pipe sizes and dimensions shall be as shown below. All pipe shall be green or white in color with factory marked homing lines. Fittings shall meet the same specification requirements as pipe.

Nom. Size	Outside Diameter		Min. Wall Thickness SDR–26
	Average	Tolerance	
4	4.215	± 0.009	.162
6	6.275	± 0.011	.241
8	8.400	± 0.012	.323
10	10.500	± 0.015	.404
12	12.500	± 0.018	.481

Tests on PVC Pipe – Pipe shall be designed to pass all tests at 73 °F. (3 °F.).

B. Ductile Iron – Shall conform to ANSI A 21.50 (AWWA C 150), ANSI A 21.51 (AWWA C 151) and ASTM A 746. All pipe shall be Pressure Class 350 unless otherwise noted. All ductile iron pipes and fittings shall be bituminous coated on the outside and lined with Protecto 401 Ceramic Epoxy or equivalent on inside.

1. Coating on the outside shall be an asphaltic coating approximately 1 mil thick. Finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to sun and shall be strongly adherent to the iron.

2. Protecto 401 Ceramic Epoxy or equivalent interior lining shall conform to ASTM E 96, ASTM D 714, ASTM D 2794 and ASTM G 53. Interior of the pipe shall receive 40 mils nominal dry film thickness of epoxy. Lining application, inspection, certification, handling, and surface preparation of area to receive the protective coating shall be in accordance with manufacturer's specifications and requirements.

2.02 JOINTS – GRAVITY SYSTEM

A. Joints for Ductile Iron Pipe – Shall be slip–on rubber equivalent to "Fastite," "All–

tite," or "Tyton."

B. Joints for PVC Pipe – Shall be integral wall bell and spigot with a rubber ring gasket. Joints shall conform to ASTM D 3212 and gaskets to ASTM F 477.

2.03 FORCE MAIN

A. P.V.C. – All pipe shall be green in color with factory marked homing lines. Pipe with diameter less than 4 inches shall conform to all requirements of ASTM D 2241, SDR 26, Class 160. Pipe 4 inches through 12 inches shall conform to all requirements of AWWA C900, DR 25, Pressure Class of 165 p.s.i. Pipe 14 inches through 18–inches shall conform to all requirements of AWWA C905 with C1 outside diameter, DR 25, with a pressure rating of 165 p.s.i. Joints shall be in accordance with ASTM D 3139.

B. Ductile Iron pipe shall be in accordance with Paragraph 2.1–B and conform to ASTM A 377. Push–on–Joints shall be slip–on rubber equivalent to "Fastite," "All–tite," or "Tyton." Flanged joints shall conform to AWWA C 115. Gaskets shall conform to AWWA C 111.

C. Thrust blocking shall be sized as detailed on the construction drawings of 3,000 p.s.i. concrete. Blocking shall be provided at all bends deflecting 11–1/4° or more and bear directly against the undisturbed trench wall.

D. Restrained Joints – Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Megalug" or push–on type joints equivalent to "Lok–Ring," "TR Flex," or "Super Lock" and shall have a minimum rated working pressure equal to the item restrained with a minimum safety factor of 2:1. Joints shall be in accordance with the applicable portions of AWWA C–111. Manufacturer of joints shall furnish certification, witnessed by an independent laboratory, stating joints furnished have been tested without signs of leakage or failure. Restrained joints shall be capable of being deflected after assembly.

2.04 STONE BACKFILL

A. Shall be graded crushed granite with the following gradation:

Square Opening Size	Percent Passing
1 inch	100%
3/4 inch	90 to 100%
3/8 inch	0 to 65%
No. 4	0 to 25%

2.05 AIR RELEASE VALVE

A. Shall be designed for sewage service. The valve shall be constructed of a cast iron body, stainless steel or bronze trim, and stainless–steel float. The inlet shall be two inches. The working pressure shall be 0 to 50 p.s.i. It shall be on automatic air valve.

2.06 METAL DETECTOR TAPE

A. Will be installed above all pipe. Tape shall consist of 0.35 mils thick solid foil core encased in a protective plastic jacket resistant to alkalis, acids, and other destructive elements found in the soil. The lamination bond shall be strong enough, so layers cannot be separated by hand. Total composite thickness shall be 5.0 mils. Foil core to be visible from unprinted side to ensure continuity. The tape shall have a minimum three–inch width and a tensile strength of 35 pounds per inch.

A continuous warning message indicating "sewer line" repeated every 16 inches to 36 inches shall be imprinted on the tape surface. Tape shall contain an opaque color concentrate designating color code appropriate to the line being buried (Sewer Line – Green).

2.07 MANHOLES

A. Masonry – Shall be new whole brick of good quality laid in masonry mortar or cement mortar made of one–part Portland cement and two parts clean sharp sand. Every brick shall be fully bedded in mortar. Manholes shall conform to locations and details shown on the plans.

B. Precast Concrete – Shall be reinforced concrete constructed in accordance with ASTM C 478 and details shown on the plans "Precast Concrete Manholes." Coarse aggregate shall be granite stone. The joints shall be tongue and groove sealed with flexible gaskets or mastic sealant. Gaskets shall be O–Ring or equivalent to Type A or B "Tylox" conforming to ASTM C 443. Mastic shall be equivalent to "Ram–nek" with primer. Primer shall be applied to all contact surfaces of manhole joint at the factory in accordance with manufacturer's instructions.

C. Frames and Covers – Shall be cast iron equivalent to the following:

[Model V1327–1 RG V1327GS EPIC SAVANNAH SN manufactured by E.J.]

D. Manhole Steps – Shall be equivalent to M.A. Industries, Type PS–1 or PS–2–PF. Steps shall be installed at the manhole factory and in accordance with recommendations of step manufacturer. Manholes will <u>not</u> be acceptable if steps are not installed accordingly.

E. Pipe Connections – Shall have flexible watertight joints at sewer main point of entry into the manhole. The joint shall be polyisoprene sleeve equivalent to "Kor–N–Seal", A–lock or equal.

F. Coatings – New manholes shall have all interior surfaces coated with a factory applied acrylic polymer–based coating and sealant. The coating shall be ConSeal CS–55 manufactured by Concrete Sealants, New Carlisle, Ohio or an accepted equivalent. The coating shall be applied in three coats to achieve a total dry film thickness of at least 3.5 mils in accordance with manufacturer's recommendations. Surfaces shall be cleaned of all dust, form oils, curing compounds and other foreign matter prior to the coating application.

All new force main discharge manholes drop manholes or drop manholes shall be coated with 125 wet film mils of Raven 405 ultra–high build epoxy or an accepted equivalent. The interior surfaces shall be cleaned and prepared according to manufacturer's recommendations..

2.08 PLANT'S SUBMERISIBLE PUMP STATIONS

2.08.1 *INFLUENT PUMP STATION*

A. Proposed configuration of the influent pump station includes for Phase I – two (2) existing submersible Flygt CP 3231/605 pumps and installation of one (1) new stand–by Flygt model NP 3306/665 pump within an existing concrete wet well structure. Phase II shall include existing Phase I three (3) duty pumps and additional installation of one (1) Flygt NP 3306/665 pump (4th pump shall be installed in Phase II). Proposed pumps shall be equivalent to Flygt model conforming to characteristics shown on the drawings and mentioned hereinafter:

Pump Station

Flygt	NP 3306/665, 455mm Impeller
TDH	61
Pump Capacity	3,500 Gallons per minute
Maximum RPM	880
Phase	3
Voltage	460
Minimum HP	85
Minimum Efficiency	77.8 %

1. Contractor shall remove 8" base of the two (2) existing pumps (currently not in use) and replace them with 12" base to accommodate the new Flygt model NP 3306 pumps. Contractor shall furnish and install guide bars for each new pump (2 each) to permit raising and lowering the pump. Guide bars shall be stainless steel and of adequate length and strength to extend from lower guide holders on the pump discharge connection to upper guide holder mounted on access frame.
2. The contractor shall replace the existing (4) pumps VFD (as shown on electrical plans). All pumps shall be equipped with the soft start as a back-up to VFD.
3. Pump Control- The influent pump shall be controlled via the new level sensors and by the PLC provided by the SCADA control System.

2.08.2 *PLANT DRAIN PUMP STATION*

A. Shall be dual submersible pumps installed in a concrete wet well. Pumps shall be equivalent to Flygt conforming to characteristics shown on the drawings and mentioned hereinafter:

Pump Station

Flygt	NP 3171 MT 3- 436 mm Impeller
TDH	56
Pump Capacity	1,000 Gallons per minute
Maximum RPM	1,755
Phase	3

Voltage	460
Minimum HP	25
Minimum Efficiency	74

1- The pumps shall be equipped with VFD's.

2- Pump Control- The Drain pump station shall be controlled via the Ultrasonic level transmitter and by the PLC provided by the SCADA control System.

3- Floats – Furnish two additional floats for high alarm and low alarm.

B. Wet Well Sections – Shall be precast reinforced concrete sections. The product design, performance, materials, manufacturing, handling, and installation shall conform to following references and project specifications:

ACI 318 – Building Code Requirements for Reinforced Concrete

ASTM C 39 – Compressive Strength of Cylindrical Concrete Specimens

ASTM C–478 – Precast Reinforced Concrete Manhole Sections

ASTM C 890 – Minimal Structural Design Loading for Precast Concrete Water and Wastewater Structures

ASTM C 891 – Installation of Underground Precast Concrete Utility Structures

ASTM C 913 – Precast Concrete Water and Wastewater Structures

1. Contractor or supplier shall provide for design of the precast structure. Each section of the structure shall be designed and manufactured for its individual depth, loading conditions (lateral, surcharge and hydrostatic), and opening requirements. All concrete in the precast structure shall have a minimum compressive strength of 4,500 p.s.i. after 28 days. Reinforcing steel shall comply with ASTM A 615 Grade 60 (min. fy = 60,000 p.s.i.). Bar bending, and placement shall comply with the ACI latest standards.

2. Precast structure manufacturer shall have necessary equipment and facilities for proper manufacture of the sections and to perform compressive strength tests on concrete tests specimens. Test cylinders shall be made for each structure and test conducted in accordance with ASTM C 39, except compressive strength shall be equal to or greater than design of the concrete. Structure design computations, concrete mix design, and test reports certifying design strength has been achieved at the 28-day break shall be submitted to Engineer. Design of structure shall be performed by a Professional Engineer registered in the state of installation at Contractor's expense. The design parameters for a precast structure shall include:

   a. Lateral load based on a water table at the surface using equivalent fluid pressure of 80 p.c.f. from surface grade down and a vehicle wheel load designation of HS20–44. Design live load for the top slab shall be 300 p.s.f. The precast concrete sections shall have a minimum wall thickness of nine inches and minimum top slab of ten inches and bottom slab thicknesses of twenty–two inches. Actual thicknesses greater than minimum shall be as required by the loading conditions.

b. Access hatches in the top slab of wet–well structure shall be for clear opening dimensions indicated and have a load capacity of 300 p.s.f. The material shall be Aluminum Alloy 6063–T5 and T6, minimum 1/4-inch-thick plate, flush–type lock with inside spoon handle. The frame shall be complete with hinged and hasp–equipped cover, upper guide holders, chain holders and cable holder. Chain and cable holders shall be stainless steel or aluminum. Frame shall be securely mounted above the pumps. The hatch covers shall be torsion–bar loaded for ease of lifting and shall have a safety–locking handle in open position. Access hatch shall be provided with a safety grate.

3. Contractor shall furnish and install guide bars for each pump to permit raising and lowering the pump. Guide bars shall be stainless steel and of adequate length and strength to extend from lower guide holders on the pump discharge connection to upper guide holder mounted on access frame.

4. The wet well shall be provided with sleeves, 24 inches below finished grade, for access of power and control conduits. The sleeves shall be of proper size and number to accommodate all necessary power and control conduits.

5. All interior concrete surfaces shall have either a minimum 125 mils coating of Raven 405, or an accepted equivalent.

6. The structure manufacturer shall prepare and submit six sets of shop drawings showing wall and slab thicknesses, structural reinforcing and opening locations. The manufacturer shall also provide design analyses and calculations to show all sections have been designed for burial depths shown on construction drawings as well as stresses incurred during transport, handling and installation. Calculations and analyses must be performed and sealed by a Licensed Professional Engineer from the state project is located and submitted for review. All shop drawings and design calculations shall be submitted to the Contractor for review. Contractor shall forward these documents to the Engineer. Such documents shall bear the stamp or written statement of Contractor indicating Contractor's review for completeness and receipt. Contractor shall be responsible for the accuracy of shop drawings and for their conformity to plans and specifications. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by Contract Documents.

B. Pump Design – Pumps shall be capable of handling raw, unscreened sewage with the capacity to pass three–inch diameter spheres. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet–well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O–ring or profile gasket will not be acceptable. The entire weight of the pump/motor unit shall be borne by the pump discharge elbow. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with lifting chain or stainless-steel cable. The working load of the lifting system shall be 50% greater than the pump unit weight.

C. Pump Construction – Major pump components shall be of grey cast iron, ASTM A 48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 316 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal to metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or optional Viton rubber O rings. Joint sealing will be the result of controlled compression of rubber O rings in two planes and O ring contact of four sides without the requirement of a specific bolt torque limit. Rectangular cross sectioned rubber, paper or synthetic gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O rings, grease or other devices shall be used.

1. MOTOR

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 stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the current–UV–dip impregnation method using Class H monomer–free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. 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. The use of bolts, pins or other fastening devices requiring penetration of the stator housing is not acceptable. 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.

Thermal switches shall be embedded in the stator end coils to monitor the temperature of each phase winding. One PT–100 type temperature sensor shall be installed in the stator winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. A mechanical float switch (FLS) shall be mounted in the junction chamber to signal if there is water intrusion. A pump memory module shall be provided and mounted in the junction chamber to record pump run time, number of starts as well as contain the motor unit performance and manufacturing data and service history. The use of wire nuts or crimp–type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104°F) ambient and with a temperature rise not to exceed 80°C. A performance chart shall be provided upon request showing curves for torque, current, power factor, input/output kW and efficiency. This chart shall also include data on starting and no-load characteristics.

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 chlorinated polyethylene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut off through run out.

2. PILOT CABLE

The pilot cable shall be designed specifically for use with submersible pumps and shall be type SUBCAB (Submersible Cable). The cable shall be multi–conductor type with stainless steel braided shielding, a chlorinated polyethylene rubber outer jacket and tinned copper conductors insulated with ethylene–propylene rubber. The conductors shall be arranged in twisted pairs. The cable shall be rated for 600 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.

3. BEARINGS

The pump shaft shall rotate on at least three grease–lubricated bearings. 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.

The minimum L10 bearing life shall be 100,000 hours at any point along the usable portion of the pump curve at maximum product speed.

The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down.

4. MECHANICAL SEAL

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 hydro–dynamically 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 tungsten–carbide seal ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall be a leakage–free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion resistant tungsten–carbide seal ring. The rotating seal ring shall have small back–swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. The 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. For special applications, other seal face materials shall be available.

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.

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.

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.

The motor shall be able to operate continuously while non–submerged without damage while pumping under load.

Seal lubricant shall be non–hazardous.

5. 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 AISI 431 stainless steel.

6. IMPELLER – Hard–Iron®

The impeller shall be of Hard–Iron ® (ASTM A–532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi–vane, back swept, screw–shaped, non–clog design. The impeller leading edges shall be mechanically self–cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

7. VOLUTE / SUCTION COVER

The pump volute shall be a single piece grey cast iron, ASTM A–48, Class 35B, non–concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral–shaped, sharp–edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard–Iron ® (ASTM A–532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi–vane semi–open impeller and the volute housing.

D. Cooling System

Each pump/motor unit shall be provided with an integral, self-supplying cooling system. The motor water jacket shall encircle the stator housing and shall be of cast iron, ASTM A 48, Class 35B. The water jacket shall thus provide heat dissipation for the motor regardless of whether the motor unit is submerged in the pumped media or surrounded by air. After passing through a classifying labyrinth, the impeller back vanes shall provide the necessary circulation of the cooling liquid, a portion of the filtered pump media, through the cooling system. 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 provided to facilitate 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. The internals to the cooling system shall be non–clogging by virtue of their dimensions. Drilled and threaded provisions for external cooling and, seal flushing or air relief are to be provided. The cooling jacket shall be equipped with two flanged, gasketed and bolted inspection ports of not less than 4"Ø located 180° apart. 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.

1. Influent Pumps Cooling system – Integrated cooling is a self–supplying system. A portion of the pumped liquid is circulated from the pump housing up between the cooling jacket and the stator housing. The necessary flow is created by back–vanes on the impeller top. The flow is then directed in and out of the cooling jacket by a guide ring. Any air is automatically removed from the system by the air ventilation pipe. Sedimentation in the cooling system is prevented by keeping the water velocity up in the critical areas. Speed limitations must be checked for variable frequency drive (VFD) duty.

2. Drain Pump Station Pumps Cooling System – Closed loop cooling means that the cooling liquid is pumped up through the narrow space between the thin inner cooling jacket and the stator housing. The coolant is then circulated downwards between the inner and outer cooling jacket down to the cooling bottom. Finally, the coolant bottom transfers the heat from the coolant to the pumped media.

E. Pump Test – Pump manufacturer shall perform following tests on each pump before shipment from the factory:

1. Megger the pump for insulation breaks or moisture.

2. Prior to submergence, the pump shall be run dry and checked for correct rotation.

3. Pump shall be run for 30 minutes in a submerged condition.

4. Pump shall be removed from test tank, meagered immediately for moisture; oil plugs removed for checking of upper seal and possible water intrusion of stator housing.

5. A written certified test report giving above information shall be supplied with each pump at the time of shipment.

6. All pump cable ends will then be fitted with a rubber shrink fit boot to protect cable prior to electrical installation.

G. Alarm – A high–water alarm shall be supplied. A red flashing light shall be supplied in separate NEMA 4X enclosure for mounting at the control box. An audible alarm consisting of a weatherproof bell with automatic reset silencer switch and signal light shall be installed in addition to the flashing red light alarm.

H. Shop Drawings:

1. Contractor shall submit for review by Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs,

diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements. Model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.

2. All shop drawings shall be completely checked and marked accordingly with Contractor's stamp prior to submitting drawings to the Engineer for review. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and will be returned to the Contractor. Where shop drawings are "Furnished as Corrected," the reviewer has noticed deficiencies in compliance with contract specifications and drawings. It is understood corrections indicated will be incorporated by Contractor in the final product, operation and maintenance manuals and shop drawings submitted at completion of project. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by contract documents.

I. Pump Warranty – The pump manufacturer shall warrant pumps being supplied to Owner against defects in workmanship and materials for a period of five years under normal use, operation, and service. In addition, manufacturer shall replace certain parts which become defective through normal use and wear on a progressive schedule of cost for a period of five years. Parts included are the mechanical seal, impeller pump housing, wear ring, and ball bearings. The warranty shall be in published form and apply to all similar units.

J. Operation and Maintenance Manual – The pump manufacturer shall furnish Owner with a minimum of six manuals for pumps installed.

K. Provide Programmable Logic Controller (PLC) to integrate into the overall plant SCADA system.

2.09 EQUALIZATION TANK PUMP STATION

A. Phase I shall include installation of two (2) duty vertically– mounted dry well pumps and one (1) stand–by pump. Phase II shall include three (3) duty pumps (installed in Phase I) and one (1) new stand–by pump. Pumps shall be equivalent to Flygt model conforming to characteristics shown on the drawings and mentioned hereinafter:

Pump Station

Flygt	NT 3202 LT 342mm Impeller
TDH	33
Pump Capacity	4,800 Gallons per minute
Maximum RPM	1,170
Phase	3
Voltage	460
Minimum HP	60
Minimum Efficiency	81 %

1. Type of Installation – Proposed EQ Pumps are semi–open, multi vane, non–clogging, self–cleaning permanently connected to inlet and outlet pipes in dry pit pumps. The work shall include furnishing, installing, and testing of the proposed pumps, valves and appurtenances. Contractor shall provide concrete support slab with dimensions according to the construction plans.

B. Pump Design – Pump shall be capable of operating in a continuous non–submerged condition in a vertical (NT) position in a dry pit installation, 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.
Inlet elbow shall have an inspection cover – standard.

C. Pump Construction – Major pump components shall be of grey cast iron, ASTM A–48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts or bolts shall be of stainless-steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal–to–metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber O–rings. Fittings will be the result of controlled compression of rubber O–rings in two planes and O–ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O–rings, grease or other devices shall be used.

1. 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 stator windings shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer–free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. 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. The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable. The motor shall be designed for continuous duty while handling pumped media of up to 104°F. The motor shall be capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.

The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp–type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The motor service factor (combined effect of voltage, frequency and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of +/– 10%. The motor shall be designed for continuous operation in up to a 40°C ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no–load characteristics.

Motor horsepower shall be sufficient so that the pump is non–overloading throughout its entire performance curve, from shut–off to run–out. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

Optional – Shielded Power Cable:
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 power cable shall be of a shielded design in which an overall tinned copper shield is included, and each individual phase conductor is shielded with an aluminum coated foil wrap. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

This cable is required for use with Flygt SmartRunTM intelligent controls.

2. BEARINGS

The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a two-row angular contact ball bearing. The lower bearing shall be a two-row angular contact ball bearing to handle the thrust and radial forces. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

3. MECHANICAL SEALS

Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten–carbide ring. The upper secondary seal located between the seal chamber and the seal inspection chamber shall be a leakage–free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten–carbide seal ring. The rotating seal ring shall have small back–swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. 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 are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.

Seal lubricant shall be non–hazardous.

4. PUMP SHAFT

The pump and motor shaft shall be a single piece unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100–T. Shaft sleeves will not be acceptable.

5. IMPELLER

The impeller shall be of Hard–IronTM (ASTM A–532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi–open, multi–vane, back swept, screw–shaped, non–clog design. The impeller leading edges shall be mechanically self–cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag–laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

6. VOLUTE / SUCTION COVER

The pump volute shall be a single piece grey cast iron, ASTM A–48, Class 35B, non–concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral–shaped, sharp–edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard–IronTM (ASTM A–532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi–vane semi–open impeller and the volute housing.

D. Cooling System

Each unit shall be provided with an integral motor cooling system. A stainless-steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

1. EQ Pump Station Pumps Cooling System – Closed loop cooling means that the cooling liquid is pumped up through the narrow space between the thin inner cooling jacket and the stator housing. The coolant is then circulated downwards between the inner and outer cooling jacket down to the cooling bottom. Finally, the coolant bottom transfers the heat from the coolant to the pumped media.

E. Pump Test – Pump manufacturer shall perform following tests on each pump before shipment from the factory:

1. Megger the pump for insulation breaks or moisture.

2. Prior to submergence, the pump shall be run dry and checked for correct rotation.

3. Pump shall be run for 30 minutes in a submerged condition.

4. Pump shall be removed from test tank, meagered immediately for moisture; oil plugs removed for checking of upper seal and possible water intrusion of stator housing.

5. A written certified test report giving above information shall be supplied with each pump at the time of shipment.

F. Pump Controls for the EQ Pump Station – To synchronize the operation of pumps with variations of sewage level in the equalization tank, The SCADA supplier shall provide Owner approved ultrasonic transmitter to determine pump–on, lag pump on, pump–off, and high–level alarm conditions. Installation will be in accordance with the manufacturer's instructions.

1. Floats – Furnish two additional floats for high alarm and low alarm.

2. An alternator shall also be provided to change operation sequence of pumps at the completion of each pumping cycle. Provisions shall also be made for pumps to operate in parallel if level in the equalization tank continues to rise above the "pump–on" cycle. Contractor shall furnish and install one automatic control center, equipped with individual disconnects, reduced voltage solid state starter (RVSS), variable frequency drive controller assembly, 3–phase, overload and phase protection, electrical alternator, automatic transfer to non–operating pump in event of overload in operating pump, overload reset, hand–off–automatic pump operation selector switch, 24–volt control circuit transformer, and terminal board with connections for high–level alarm. All components shall be housed in a NEMA 4X enclosure. Pump controls shall be mounted on the equipment backboard and installed within an existing Influent Pump Station Motor Control Center room. Cables provided for pump feeders and pump controls shall be installed in conduit.

G. Alarm – A high–water alarm shall be supplied. A red flashing light shall be supplied in separate NEMA 4X enclosure for mounting at the control box. An audible alarm consisting of a weatherproof bell with automatic reset silencer switch and signal light shall be installed in addition to the flashing red light alarm.

H. Shop Drawings:

1. Contractor shall submit for review by Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs, diagrams, performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements. Model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.

2. All shop drawings shall be completely checked and marked accordingly with Contractor's stamp prior to submitting drawings to the Engineer for review. Shop drawings with insufficient or incomplete data required to indicate compliance with these specifications are not acceptable and

will be returned to the Contractor. Where shop drawings are "Furnished as Corrected," the reviewer has noticed deficiencies in compliance with contract specifications and drawings. It is understood corrections indicated will be incorporated by Contractor in the final product, operation and maintenance manuals and shop drawings submitted at completion of project. Rejected shop drawings shall not relieve Contractor from completing the project within time allowed by contract documents.

I. Pump Warranty – The pump manufacturer shall warrant pumps being supplied to Owner against defects in workmanship and materials for a period of five years under normal use, operation, and service. In addition, manufacturer shall replace certain parts which become defective through normal use and wear on a progressive schedule of cost for a period of five years. Parts included are the mechanical seal, impeller pump housing, wear ring, and ball bearings. The warranty shall be in published form and apply to all similar units.

J. Operation and Maintenance Manual – The pump manufacturer shall furnish Owner with a minimum of six manuals for pumps installed.

K. Provide Programmable Logic Controller (PLC) to integrate into the overall plant SCADA system. Provide equipment, conduit, and wiring as need to prove a fully functional system.

2.10 CHECK VALVES

A. Shall be designed for sewage service. The valve shall be cast iron and bronze fitted. The valve shall be a spring and lever type with neoprene seat and O–Ring seals on a stainless–steel valve pin, for pipes three inches and larger in diameter. For check valves smaller than three inches, the valve shall be a fully ported 150 p.s.i. rated ball check valve with a corrosion resistant phenolic base and a rubber seat. Check valve shall be of full waterway design for quiet operation and with a flow area through the valve equal to or exceeding flow area of pipe to which it is installed.

2.11 PLUG VALVES

A. Shall be fully ported and of the same diameter as pipes to which they are attached. They shall have semi–steel bodies, all metal plugs, stainless steel bearings, and be equivalent to DeZurik Series 100 eccentric valves, lever operated. All valves larger than eight inches shall be equipped with gear actuator and handwheel.

2.12 FLOW METER

A. Flow Meter shall be as specified elsewhere.

2.13 PRODUCT REVIEW

A. Contractor shall provide the Engineer with a complete description of all products before ordering. Engineer will review all products before they are ordered by Contractor.

PART 3 – EXECUTION

3.01 CONSTRUCTION OBSERVATION

A. The pump station operation shall be tested by Contractor under the direction of Engineer. Engineer or Project Representative will have the right to require any portion of work be completed in their presence. If work is covered up after such instruction, it shall be exposed by Contractor for observation. However, if Contractor notifies Engineer such work is scheduled and Engineer fails to appear within 48 hours, the Contractor may proceed. All work completed, and materials furnished shall be subject to review by the Engineer or Project Representative. All improper work shall be reconstructed. All materials not conforming to requirements of specifications shall be removed from the work upon notice being received from Engineer for rejection of such materials. Engineer shall have the right to mark rejected materials to distinguish them as such.

B. Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours' notice for all required observations or tests.

C. It will also be required by Contractor to keep accurate, legible records of the location of all appurtenances. These records will be prepared in accordance with "Record Data and Drawings" paragraph in the Special Conditions. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.02 PARTIAL ACCEPTANCE OF THE WORK

A. Owner reserves right to accept and use any part of the work. Engineer shall have power to direct on what line the Contractor shall work and order thereof.

3.03 RECORD DATA

A. It will be required of the Contractor to keep accurate, legible records, locating all as–built conditions. These records will be made available to Engineer before final review for incorporation into the Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

3.04 AIR RELEASE VALVE

A. The installation of valve shall be where shown on the plans and in accordance with standard drawings.

3.05 PUMPING STATION

A. Install pumps including fittings, brackets, discharge piping, check valve to basin rail assembly, plug valve, and lifting device according to manufacturer's recommendation.

B. Contractor shall provide, at minimum, spare parts to include but not limited to:

1. One spare pump motor starter.
2. One of each seal assemblies.
3. One complete set of bearings.
4. One set of wear rings.
5. One of each type relay.
6. One pump alternator.
7. One float switch with cable.
8. One of each type pilot light.
9. One box of each type lamp.

3.06 STATION STARTUP, INITIAL TESTING, AND OPERATION

A. Notify Engineer personnel five working days prior to flow rate testing.

B. Hydraulically test station to performance requirements.

C. Correct failures during test by repairing or replacing malfunctioning parts or equipment of faulty workmanship, regardless of cause, within 24 hours.

D. After correcting failures caused by defective equipment, material, or faulty workmanship, retest until failures are eliminated.

E. Confirm general sequencing of pump and float operations at basin and control panel are in accordance with performance requirements and Utility requirements.

F. Adjust pumps and control panel system to conform to performance requirements.

G. Document and certify startup results in start–up report.

3.07 MANUFACTURER'S FIELD SERVICE

A. Furnish factory trained representative and field technical assistance during the following periods of pumping station installation:

1. Unloading of station materials and components.
2. Start–up, testing, and demonstration of station systems pump, and control panel.

3.08 LEAKAGE

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons per day per inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low–pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low–pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is two feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least two feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re–established. The amount of water required to maintain this water level during a two–hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of two hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches- 2.40 gallons

3.09 CLEANING AND ACCEPTANCE

A. Before acceptance of sewer system, it shall be tested and cleaned to the satisfaction of Engineer. Where any obstruction is met, Contractor will be required to clean sewers by means of rod and swabs or other instruments. The pipe line shall be straight and show a uniform grade between manholes. The Engineer shall check lines by lamping or other methods to determine final acceptance.

3.09 CLOSING PIPE

A. When work or pipe installation is suspended, either for the night or at other times, end of sewer must be closed with a tight cover. Contractor will be held responsible for keeping the sewer free from obstruction.

3.10 PUMPING STATIONS

A. The precast sections shall be carefully handled and placed in position undamaged. Spalled areas, cracks, or exposed reinforcing in any section shall be cause for rejection of a section. Damaged elements shall be promptly removed from the job–site.

The structure shall be installed plumb and level by Contractor on a prepared, evenly distributed and level, minimum 12–inch–thick crushed–stone bed. Joints between sections shall be sealed with butyl–rubber or neoprene sealant. Asphaltic–based material or similar products shall not be used. The sealant shall be applied in accordance with sealant manufacturer's recommendation. Leakage through joints or around pipes will not be acceptable. Grout used at construction joints and around pipes shall be Five Star brand non–shrink grout or an acceptable equivalent.

Excavation shall be accomplished in a manner as required to protect adjacent property and utilities and for safety. Backfilling shall be accomplished as soon as practicable after the structure has been placed and sealed. Backfilling shall be achieved by placing material in equal lifts (maximum two feet) and compacting each lift to maintain stability and plumbness of the structure. Backfill material shall be a select granular material with a maximum plasticity index (P.I.) of 12. Compaction shall be accomplished by means of mechanical tamping to 98% of maximum laboratory density at optimum moisture when tested by ASTM D 6938. During backfilling operation and until its completion, the wet well sections shall be maintained in an absolute plumb position. To prevent structure from possibly becoming buoyant in hydrostatic or flooded conditions, Contractor shall take necessary steps to avoid flotation of the structure.

Drawings indicate the general arrangement and location of electrical equipment, conduit, piping, transformer, and generator. Installation and location of these items shall be coordinated with the pump station operating personnel.

3.11 FORCE MAIN

A. Ductile Iron Force Main shall be installed in accordance with AWWA C 600.

B. PVC Force Main shall be installed in accordance with ASTM D 2774.

C. Crossings with water mains shall conform to City of Savannah Public Works and Water Resources Bureau Cross Connection Control Policy.

END OF SECTION

INDEX TO

SECTION 33 32 21 – FLOW DIVERSION

SECTION 33 32 21

FLOW DIVERSION

PART 1 – GENERAL

1.1 SCOPE

A. Contractor is required to furnish all materials, labor, equipment, power, maintenance, etc. to implement a temporary pumping system for diverting the flow to the Lift Station #40 during the pump station modifications. Temporary pumping system includes, but is not limited to, all line stops, wet taps, pumps, temporary power and controls, etc. necessary to keep the lift station operational at all times until the work is complete.

B. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The Contractor shall employ the services of a vendor who can demonstrate to the Engineer that he specializes in the design and operation of temporary bypass pumping systems. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

1.2 SUBMITTALS

A. The Contractor must submit a plan for temporary bypass of the lift station. The plan must include specific details such as pump capacities, power supply, alarms and controls. The plan must specify contact names and phone numbers for the Contractor's personnel responsible for the bypass. A schedule for implementation of the bypass and completion of the necessary work must also to be included in the plan.

B. The Contractor shall submit to the Engineer detailed plans and a description outlining all provisions and precautions to be taken by the Contractor regarding the handling of existing wastewater flows. This plan must be specific and complete, including such items as schedules, locations, elevations, capacities of equipment, materials and all facilities, including protection of the access and bypass pumping locations from damage due to the discharge flows, and compliance with the requirements and permit conditions specified in these Contract Documents. No construction shall begin until all provisions and requirements have been reviewed by the Engineer.

C. The plan shall include but not be limited to details of the following:

1. Staging areas for pumps;
2. Sewer Plugging method and types of plugs;
3. Number, size, material, location and method of installation of suction piping;
4. Number, size, material, method of installation and location of installation of Discharge piping;
5. Bypass pump sizes, capacity, number of each size to be on site and power requirements;
6. Calculations of static lift, friction losses, and flow velocity (pump curves showing pump operating range shall be submitted);
7. Standby power generator size and location;
8. Downstream discharge plan;

9. Method of protecting discharge manholes or structures from erosion and damage;
10. Thrust and restraint block sizes and locations;
11. Sections showing suction and discharge pipe depth, embedment, select fill and special backfill;
12. Method of noise control for each pump and/or generator;
13. Any temporary pipe supports, and anchoring required;
14. Design plans and computation for access to bypass pumping locations indicated on the drawings;
15. Calculations for selection of bypass pumping pipe size;
16. Schedule for installation of and maintenance of bypass pumping lines;
17. Plan indicating selection location of bypass pumping line locations.

PART 2 – PRODUCTS

2.1 EQUIPMENT

A. All pumps used shall be fully automatic self-priming units that do not require the use of foot-valves or vacuum pumps in the priming system. The pumps may be electric, or diesel powered. All pumps used must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows. All pumps must have solar batteries and solar battery chargers, both provided by the same manufacturer.

B. The Contractor shall provide the necessary stop/start controls for each pump.

C. The Contractor shall include one stand-by pump of each size to be maintained on site. Back-up pumps shall be piped and completely on-line, isolated from the primary system by a valve only.

D. Discharge Piping – In order to prevent the accidental spillage of flows, all discharge systems shall be temporarily constructed of rigid pipe with positive, restrained joints. Under no circumstances will aluminum "irrigation" type piping or glued PVC pipe be allowed. Discharge hose will only be allowed in short sections and by specific permission from the Engineer.

E. Pumps shall be provided with solar batteries and solar battery powered chargers for the bypass pump starters. Both the batteries and the chargers are to be provided by the same manufacturer.

F. All fuel required for the bypass pumps is the responsibility of the Contractor. Pumps are to have adequate fuel at all times while on site.

2.2 SYSTEM DESCRIPTION

A. Design Requirements:

1. Bypass pumping systems shall have sufficient capacity to pump the wet weather peak flow of sewer. The Contractor shall provide all pipeline plugs, pumps of adequate size to handle peak flow, and temporary

discharge piping to ensure that the total flow of the main can be safely diverted around the section to be repaired. Bypass pumping system will be required to be operated 24 hours per day.

2. The Contractor shall have adequate standby equipment available and ready for immediate operation and use in the event of an emergency or breakdown. One standby pump for each size pump utilized shall be installed at the mainline flow bypassing locations, ready for use in the event of primary pump failure. Solar batteries and solar battery chargers are required for both pumps.

3. Bypass pumping system shall be capable of bypassing the flow around the work area and of releasing any amount of flow up to full available flow into the work area as necessary for satisfactory performances of work.

4. The Contractor shall make all arrangements for bypass pumping during the time when the main is shut down for any reason. System must overcome any existing force main pressure on discharge.

B. Performance Requirements:

1. It is essential to the operation of the existing sewerage system that there be no interruption in the flow of sewage throughout the duration of the pump station work. To this end, the Contractor shall provide, maintain and operate all temporary facilities such as dams, plugs, pumping equipment (both primary and back-up units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the sewage flow before it reaches the point where it would interfere with his work, carry it past his work and return it to the existing sewer downstream of his work.

2. The existing Lift Station shall be provided with two identical bypass pumps and back-up. Pumps are to be provided by the same manufacturer. Each pump shall be fully enclosed with sound attenuated panels by the pump manufacturer for Lift Station (<69 db at 30 feet) due to the proximity to ANG office units. Each pump shall have a minimum capacity of 3,000 gpm @ 105 ft TDH. Pumps shall be Godwin Critically Silenced Dri-Prime Pumps or equal.

3. The design, installation and operation of the temporary pumping system shall be the Contractor's responsibility. The bypass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

4. The Contractor shall provide all necessary means to safely convey the sewage past the work area. The Contractor will not be permitted to stop or impede the main flows under any circumstances.

5. The Contractor shall maintain sewer flow around the work area in a manner that will not cause surcharging of sewers, damage to sewers and that will protect public and private property from damage and flooding.

6. The Contractor shall protect water resources wetlands and other natural resources.

PART 3 – EXECUTION

3.1 GENERAL

A. In no case shall bypassing to any watercourse, storm sewer or other point where pollution may result be permitted.

B. The Contractor is responsible for all pumping and flow diversion including all necessary equipment. The City of Savannah is not obligated to supply any equipment.

C. Line stops are likely required at the Lift Station #40 for flow diversion. All line stops, and/or wet taps required are the responsibility of the contractor.

D. Bypass pumping system shall be required to have full redundancy. Backup bypass pump must be installed, including all piping and valves so that it will be fully operationally and can be placed in service immediately, if needed.

3.2 FIELD QUALITY CONTROL AND MAINTENANCE

A. Test:

1. The Contractor shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to actual operation. The Engineer will be given 24 hours notice prior to testing.

B. Inspection:

1. Contractor shall inspect bypass pumping system every two hours to ensure that the system is working correctly.

C. Maintenance Service:

1. The Contractor shall insure that the temporary pumping system is properly maintained, and a responsible operator shall be on hand at all times when pumps are operating.

D. Extra Materials:

1. Spare parts for pumps and piping shall be kept on site as required.

2. Adequate hoisting equipment for each pump and accessories shall be maintained on the site.

3.3 PREPARATION

A. Precautions

1. Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass pipelines. The Contractor shall locate his bypass pipelines to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from the City and the Engineer. All costs associated with relocating utilities and obtaining all approvals shall be paid by the Contractor.

2. During all bypass pumping operation, the Contractor shall protect the Pumping Station and main and all local sewer lines from damage inflicted by any equipment. The Contractor shall be responsible for all physical damage to the Pumping Station and main and all local sewer lines caused by human or mechanical failure.

3.4 INSTALLATION AND REMOVAL

A. The Contractor shall modify or remove manhole sections (if needed) or make connections to the existing sewer and construct temporary bypass pumping structures only at the location indicated on the Drawings and as may be required to provide adequate suction conduit.

B. Plugging or blocking of sewage flows shall incorporate primary and secondary plugging device. When plugging or blocking is no longer needed for performance and acceptance or work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging or causing other major disturbances downstream.

C. When working inside manhole or force main, the Contractor shall exercise caution and comply with OSHA requirements when working in the presence of sewer gases, combustible oxygen-deficient atmospheres, and confined spaces.

D. The installation of the bypass pipelines is prohibited in all saltmarsh/wetland areas. The pipeline must be located off streets sidewalks and on shoulders of the roads. When the bypass pipeline crosses local streets and private driveways, the contractor must place the bypass pipelines in trenches and cover with temporary pavement. Upon completion of the bypass pumping operations, and after the receipt of written permission from the Engineer, the Contractor shall remove all the piping, restore all property to pre-construction condition and restore all pavement. The Contractor is responsible for obtaining any approvals for placement of the temporary pipeline within public ways from the city.

3.5 CONTROL REQUIREMENTS

A. Contractor shall provide back-up power (i.e. generator) for all by-pass pumps required to complete the work. Contractor shall provide alarms for all by-pass pumps used to complete the work. The City of Savannah is not obligated to supply any equipment.

B. Contractor shall provide continuous bypass monitoring for bypass pumps and backup bypass pumping system.

C. Contractor shall provide 110 V power and phone service for operation of the autodialer during bypass pump operation. The City of Savannah shall install and program the existing autodialer.

D. Contractor shall provide a high-level mercury float switch in the suction manhole for the bypass pumps. The mercury float switch shall be enclosed in a smooth, chemical resistant urethane or polypropylene casing suspended on its own cable. The cable shall be of proper length to reach from the float switch in the manhole to the autodialer location without splices. The autodialer location shall be designated by the City of Savannah within the fenced portion of the lift station site. Contractor shall bury the cable for the float switch in the trench with the bypass suction lines.

3.6 EMERGENCY CONTACT REQUIREMENTS

A. Contractor shall provide two (2) emergency phone numbers that will be programmed into the existing Microtel 250 autodialer during operation of the bypass. The first two alarm calls will be made to the contractor, and the second two alarm calls will be sent to the City of Savannah. The contractor must call 351-3434 to acknowledge receipt of each alarm call.

END OF SECTION

INDEX TO

SECTION 33 41 01 – STORM DRAIN PIPING

SECTION 33 41 01

STORM DRAIN PIPING

PART 1 – GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):

a. M36M, Standard Specification for Corrugated Steel Pipe, Metallic–Coated, for Sewers and Drains.

b. M 190M, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.

c. M196M, Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains.

2. ASTM International (ASTM):

a. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.

b. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

3. Georgia Department of Transportation Standard Specifications, latest edition (GADOT Standard Specifications.)

1.02 SUBMITTALS

A. Informational Submittals: Manufacturer's Certification of Compliance.

PART 2 – PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in the Data Sheets following "End of Section" and in accordance with GADOT Standard Specification.

PART 3 – EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.

2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.

3. Pipe invert may deviate from line or grade up to 0.1 foot provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.

4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.

5. Prevent entry of foreign material into gasketed joints.

6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

7. Storm pipes shall be installed in accordance with GADOT Standard.

B. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

3.02 SUPPLEMENTS

A. The supplement listed below is part of this Specification.

1. Data Sheet:

Number	**Title**
–.05	Reinforced Concrete

DATA SHEET

SECTION 33 41 01.05 REINFORCED CONCRETE	
Item	**Description**
Pipe	In accordance with Georgia Department of Transportation Standard Specification for reinforced concrete pipe. Class III and Class IV.

END OF SECTION

INDEX TO

SECTION 33 41 02 – STORM WATER TREATMENT DEVICE

SECTION 33 41 02

STORM WATER TREATMENT DEVICE

1.0 GENERAL

1.1 This item shall govern the furnishing and installation of the CDS® by Contech Engineered Solutions LLC, complete and operable as shown and as specified herein, in accordance with the requirements of the plans and contract documents.

1.2 The Contractor shall furnish all labor, equipment and materials necessary to install the storm water treatment device(s) (SWTD) and appurtenances specified in the Drawings and these specifications.

1.3 The manufacturer of the SWTD shall be one that is regularly engaged in the engineering design and production of systems deployed for the treatment of storm water runoff for at least five (5) years and which have a history of successful production, acceptable to the Engineer. In accordance with the Drawings, the SWTD(s) shall be a CDS® device manufactured by:

Contech Engineered Solutions LLC
9025 Centre Pointe Drive
West Chester, OH, 45069
Tel: 1 800 338 1122

1.4 Related Sections

1.4.1 Section 02240: Dewatering
1.4.2 Section 02260: Excavation Support and Protection
1.4.3 Section 02315: Excavation and Fill

1.5 All components shall be subject to inspection by the engineer at the place of manufacture and/or installation. All components are subject to being rejected or identified for repair if the quality of materials and manufacturing do not comply with the requirements of this specification. Components which have been identified as defective may be subject for repair where final acceptance of the component is contingent on the discretion of the Engineer.

1.6 The manufacturer shall guarantee the SWTD components against all manufacturer originated defects in materials or workmanship for a period of twelve (12) months from the date the components are delivered to the owner for installation. The manufacturer shall upon its determination repair, correct or replace any manufacturer originated defects advised in writing to the manufacturer within the referenced warranty period. The use of SWTD components shall be limited to the application for which it was specifically designed.

1.7 The SWTD manufacturer shall submit to the Engineer of Record a "Manufacturer's Performance Certification" certifying that each SWTD is capable of achieving the specified removal efficiencies listed in these specifications. The certification shall be supported by independent third-party research

1.8 No product substitutions shall be accepted unless submitted 10 days prior to project bid date, or as directed by the Engineer of Record. Submissions for substitutions require review and approval by the Engineer of Record, for hydraulic performance, impact to project designs, equivalent treatment performance, and any required project plan and report (hydrology/hydraulic, water quality, stormwater pollution) modifications that would be required by the approving jurisdictions/agencies. Contractor to coordinate with the Engineer of Record any applicable modifications to the project estimates of cost, bonding amount determinations, plan check fees for changes to approved documents, and/or any other regulatory requirements resulting from the product substitution.

2.0 MATERIALS

2.1 Housing unit of stormwater treatment device shall be constructed of pre-cast or cast-in-place concrete, no exceptions. Precast concrete components shall conform to applicable sections of ASTM C 478, ASTM C 857 and ASTM C 858 and the following:

2.1.1 Concrete shall achieve a minimum 28-day compressive strength of 4,000 pounds per square-inch (psi);
2.1.2 Unless otherwise noted, the precast concrete sections shall be designed to withstand lateral earth and AASHTO H-20 traffic loads;
2.1.3 Cement shall be Type III Portland Cement conforming to ASTM C 150;
2.1.4 Aggregates shall conform to ASTM C 33;
2.1.5 Reinforcing steel shall be deformed billet-steel bars, welded steel wire or deformed welded steel wire conforming to ASTM A 615, A 185, or A 497.
2.1.6 Joints shall be sealed with preformed joint sealing compound conforming to ASTM C 990.
2.1.7 Shipping of components shall not be initiated until a minimum compressive strength of 4,000 psi is attained or five (5) calendar days after fabrication has expired, whichever occurs first.

2.2 Internal Components and appurtenances shall conform to the following:

2.2.1 Screen and support structure shall be manufactured of Type 316 and 316L stainless steel conforming to ASTM F 1267-01;
2.2.2 Hardware shall be manufactured of Type 316 stainless steel conforming to ASTM A 320;
2.2.3 Fiberglass components shall conform to the ASTM D-4097
2.2.4 Access system(s) conform to the following:
2.2.5 Manhole castings shall be designed to withstand AASHTO H-20 loadings and manufactured of cast-iron conforming to ASTM A 48 Class 30.

3.0 PERFORMANCE

3.1 The SWTD shall be sized to either achieve an 80 percent average annual reduction in the total suspended solid load or treat a flow rate designated by the jurisdiction in which the project is located. Both methods should be sized using a particle size distribution having a mean particle size (d_{50}) of 125 microns unless otherwise stated.

3.2 The SWTD shall be capable of capturing and retaining 100 percent of pollutants greater than or equal to 2.4 millimeters (mm) regardless of the pollutant's specific gravity (i.e.: floatable and neutrally buoyant materials) for flows up to the device's rated-treatment capacity. The SWTD shall be designed to retain all previously captured pollutants addressed by this subsection under all flow conditions. The SWTD shall be capable of capturing and retaining total petroleum hydrocarbons. The SWTD shall be capable of achieving a removal efficiency of 92 and 78 percent when the device is operating at 25 and 50 percent of its rated-treatment capacity. These removal efficiencies shall be based on independent third-party research for influent oil concentrations representative of storm water runoff (20 ± 5 mg/L). The SWTD shall be greater than 99 percent effective in controlling dry-weather accidental oil spills.

3.3 The SWTD shall be designed with a sump chamber for the storage of captured sediments and other negatively buoyant pollutants in between maintenance cycles. The minimum storage capacity provided by the sump chamber shall be in accordance with the volume listed in Table 1. The boundaries of the sump chamber shall be limited to that which do not degrade the SWTD's treatment efficiency as captured pollutants accumulate. The sump chamber shall be separate from the treatment processing portion(s) of the SWTD to minimize the probability of fine particle re-suspension. In order to not restrict the Owner's ability to maintain the SWTD, the minimum dimension providing access from the ground surface to the sump chamber shall be 16 inches in diameter.

3.4 The SWTD shall be designed to capture and retain Total Petroleum Hydrocarbons generated by wet-weather flow and dry-weather gross spills and have a capacity listed in Table 1 of the required unit.

3.5 The SWTD shall convey the flow from the peak storm event of the drainage network, in accordance with required hydraulic upstream conditions as defined by the Engineer. If a substitute SWTD is proposed, supporting documentation shall be submitted that demonstrates equal or better upstream hydraulic conditions compared to that specified herein. This documentation shall be signed and sealed by a Professional Engineer registered in the State of the work. All costs associated with preparing and certifying this documentation shall be born solely by the Contractor.

3.6 The SWTD shall have completed field tested following TARP Tier II protocol requirements

4.0 EXECUTION

4.1 The contractor shall exercise care in the storage and handling of the SWTD components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be borne by the contractor.

4.2 The SWTD shall be installed in accordance with the manufacturer's recommendations and related sections of the contract documents. The manufacturer shall provide the contractor installation instructions and offer on-site guidance during the important stages of the installation as identified by the manufacturer at no additional expense. A minimum of 72 hours notice shall be provided to the manufacturer prior to their performance of the services included under this subsection.

4.3 The contractor shall fill all voids associated with lifting provisions provided by the manufacturer. These voids shall be filled with non-shrinking grout providing a finished surface consistent with adjacent surfaces. The contractor shall trim all protruding lifting provisions flush with the adjacent concrete surface in a manner, which leaves no sharp points or edges.

4.4 The contractor shall removal all loose material and pooling water from the SWTD prior to the transfer of operational responsibility to the Owner.

TABLE 1
Storm Water Treatment Device
Storage Capacities

CDS Model	Minimum Sump Storage Capacity $(yd^3)/(m^3)$	Minimum Oil Storage Capacity (gal)/(L)
CDS2015-4	0.9(0.7)	61(232)
CDS2015-5	1.5(1.1)	83(313)
CDS2020-5	1.5(1.1)	99(376)
CDS2025-5	1.5(1.1)	116(439)
CDS3020-6	2.1 (1.6)	184(696)
CDS3025-6	2.1(1.6)	210(795)
CDS3030-6	2.1 (1.6)	236(895)
CDS3035-6	2.1 (1.6)	263(994)
CDS3535-7	2.9(2.2)	377(1426)
CDS4030-8	5.6(4.3)	426(1612)
CDS4040-8	5.6 (4.3)	520(1970)
CDS4045-8	5.6 (4.3)	568(2149)
CDS5640-10	8.7(6.7)	758(2869)
CDS5653-10	8.7(6.7)	965(3652)
CDS5668-10	8.7(6.7)	1172(4435)
CDS5678-10	8.7(6.7)	1309(4956)
CDS7070-DV	3.6(2.8)	914 (3459)
CDS10060-DV	5.0 (3.8)	792 (2997)
CDS10080-DV	5.0 (3.8)	1057 (4000)
CDS100100-DV	5.0 (3.8)	1320 (4996)

END OF SECTION

INDEX TO

SECTION 40 05 15 – PIPE HANGERS AND SUPPORTS

SECTION 40 05 15

PIPE HANGERS AND SUPPORTS

PART 1—GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. GENERAL: This section specifies hangers and supports for all exposed piping systems specified in Section 40 27 05. This section does not include pipe supports for fire sprinkler systems (if any)or seismic restraints.

2. SCOPE OF CONTRACTOR DESIGN: The Contractor shall provide the services of a "Design Professional" as specified in paragraph 40 27 05–1.01 A to conduct all necessary piping and support design for exposed piping.

   Whether a design or general arrangement is shown or not, Contractor's Design Professional shall design all pipe supports, anchorage, restraints and expansion control, as specified. Where a conflict arises, Contractor's Design Professional shall present any conflict to Construction Manager for resolution.

   The Design Professional's work shall incorporate design criteria and other conditions as specified herein, in related sections and as shown on the drawings.

   Additional requirements are specified in related sections.

3. SCOPE OF WORK BY DESIGN ENGINEER: Design Engineer has undertaken design details for supports and anchors for: selected discharge and intake manifolds; selected special installation requirements; and, selected piping 48–inches and larger. Contractor's Design Professional shall incorporate these features into the Contractor's design.

   Where shown, Design Engineer has also provided guidance in the form of general arrangements that may include specific types of supports or anchorage details. In addition, allowable anchor points and load capacities for potential support structures are shown or otherwise described herein.

B. OPERATING CONDITIONS:

The hangers and supports specified in this section are provided to resist pipe loads occurring primarily in the downward (gravity) direction. For the purpose of pipe hanger and support selection, this section establishes pipe support classifications based on the operating temperatures of the piping contents. Pipe support classifications are as follows:

1. Hot Systems
   A – 1. 120 degrees F to 450 degrees F
   A – 2. 451 degrees F to 750 degrees F
   A – 3. Over 750 degrees F

2. Ambient Systems
   B. 60 degrees F to 119 degrees F

3. Cold Systems
   C – 1. 33 degrees F to 59 degrees F
   C – 2. –20 degrees F to 32 degrees F

C. HANGER AND SUPPORT SELECTION:

The Contractor shall cause the pipe hangers and supports to be designed and selected by the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A 2. This provision, however, shall not relieve the Contractor of overall responsibility for this portion of the work. Hanger and support selection shall be based on the following:

1. The Contractor shall select pipe hangers and supports as needed to protect piping and equipment specified in the project manual. Selections shall be based upon the pipe support classifications specified in MSS–SP 69, the piping insulation thickness specified in Section 40 27 05.09, and any special requirements which may be specified by the Design Professional.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the type of support to be used at each hanger point.

3. Where a particular pipe support arrangement is shown, a design incorporating that arrangement shall be used.

4. Where a particular pipe support design is shown, that design shall be used.

5. Pipe supports shall be spaced such that pipe span deflections do not exceed 0.1–inch.

6. Pipe support design shall incorporate applicable criteria of ASME or other recognized standard.

7. The pipe hanger and support system shall be coordinated with the seismic restraint system specified under Section 40 05 15.10.

8. Hangers and supports shall withstand all static and specified dynamic conditions of loading to which the piping and associated equipment may be subjected. As a minimum, consideration shall be given to the following conditions:

   a. Weights of pipe, valves, fittings, insulating materials, suspended hanger components, and normal fluid contents.

   b. Weight of hydrostatic test fluid or cleaning fluid if normal operating fluid contents are lighter.

   c. Reaction forces due to test and operational conditions.

d. Reaction forces due to the operation of safety, relief, or other valves.

e. Wind, snow or ice loadings on outdoor piping.

f. Supports shall be designed to prevent transfer of the weight of piping, valves and piping appurtenances to equipment piping connections. All supports adjacent at equipment connections to piping systems shall have provisions for vertical and horizontal adjustment. Two flexible piping connections not less than one pipe diameter apart shall be provided between piping supports and any equipment piping connection.

9. Hangers and supports shall be sized to fit the outside diameter of pipe, tubing, or, where specified, the outside diameter of insulation.

10. Where negligible movement occurs at hanger locations, rod hangers shall be used for suspended lines, wherever practical. For piping supported from below, bases, brackets or structural cross members shall be used.

11. Hangers for the suspension of size 2 1/2 inches and larger pipe and tubing shall be capable of vertical hanger component adjustment under load.

12. The supporting systems shall provide for and control the free or intended movement of the piping including its movement in relation to that of connected equipment.

13. Where there is horizontal movement at a suspended type hanger location, hanger components shall be selected to allow for swing. The vertical angle of the hanger rod shall not, at any time, exceed 4 degrees.

14. There shall be no contact between a pipe and hanger or support component of dissimilar metals. Prevent contact between dissimilar metals when supporting copper tubing by use of copper–plated, rubber, plastic or vinyl coated, or stainless-steel hanger and support components.

15. Stock hanger and support components shall be used wherever practical.

16. Fiberglass framing channel shall be provided where specified.

The following structural criteria shall also be applied:

1. Unless otherwise specified, existing pipes and supports shall not be used to support new piping.

2. Unless otherwise specified, pipe support components shall not be attached to pressure vessels.

3. Where critical support load requirements have been identified, limiting structural load requirements are shown.

4. Pipe support hangers, brackets etc. shall be of suitable capacity and shall be appropriate to the individual structural member that is used to support

the pipe.

5. The structural integrity of existing and new members shall in no way be impacted by the placement of connections for pipe supports. For example, the tension reinforcement in reinforced concrete members shall not be impacted in any way by the placement of fasteners for pipe supports.

6. Spacing and arrangement of hangers supporting pipe shall be provided in such a manner that the loads from the pipes on existing and new structural members shall be quasi–uniform. These quasi–uniform loads shall not exceed the allowable design loads for mechanical equipment as shown on existing (not necessarily contract) drawings and as listed under Design Live Loads in the General Notes.

7. For new construction, unless otherwise shown, pipe may be supported from nearest structural element (floor, ceiling, or wall). The Design Loads for mechanical equipment, as listed in the General Notes sheet of the Structural drawings shall not be exceeded.

8. The loads and specific attachment requirements for pipe supports on new concrete Tees shall be coordinated with the Tee manufacturer and incorporated into the design of the Tees.

9. Unless otherwise specified, pipe supports from existing Tees or other roof types shall not be constructed without an evaluation of capacity and appropriate design from Contractor's Design Professional.

The following, project–specific criterion shall also be applied:

1. The spacing for pipe hangers shall not be less than 5 feet and shall not exceed 375 lbs of load for all existing pre–cast, Double Tee roof elements. For hangers off flanges of existing Tees, a washer shall be provided having minimum dimensions of 1/4 inch thick by 4-inch-long and 4 inch wide. The design and projection of those hangers above the roof shall be coordinated with the architectural roofing system.

2. For sodium hydroxide, or calcium hydroxide (lime) systems, pipe supports shall be 60 percent closer than the maximum spacing indicated for plastic piping for water service.

1.02 QUALITY ASSURANCE

A. REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design – 9th Ed.
FEDSPEC WW–H–171e–78	Hangers and Supports, Pipe
MFMA–2–91	Metal Framing Standards Publication
MSS SP–69–91	Pipe Hangers and Supports – Selection and Application
MSS SP–58–93	Pipe Hangers and Supports – Materials, Design and Manufacture

B. DESIGN:

The Contractor shall cause the design of pipe hanger and support systems to be developed in conjunction with preparation of the design seismic restraints and expansion control system by the Design Professional selected in accordance with Paragraph 40 27 05–1.01 A. The pipe system drawings specified in paragraph 40 27 05–2.04 shall show the hanger and support locations as well as the details of the seismic restraints and expansion control systems. The pipe hanger and support design drawings and calculations shall be prepared and signed by the design professional and shall bear the Design Professional's registration seal.

PART 2—PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe supports, and components shall be manufactured by B–Line, Carpenter & Patterson, Kin–Line, Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe support components shall conform to the requirements of MSS SP–69 and FEDSPEC WW–H–171e. Pipe support materials shall conform to the requirements of MSS SP–58. Metal framing system components shall conform to the metal framing manufacturers' Association Standard MFMA–2.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, pipe hangers and supports, structural attachments, fittings and accessories shall be 304 stainless steel. Nuts, bolts and washers shall also be 304 stainless steel.

B. PIPE HANGERS AND SUPPORTS:

Pipe hangers and supports of dissimilar metals than pipe shall be insulated. Pipe hangers and supports shall support pipe in the manner recommended by the pipe manufacturer and/or applicable building or piping codes.

C. RACK AND TRAPEZE SUPPORTS:

Unless otherwise specified, trapeze and pipe rack components shall have a minimum steel thickness of 12 gage, with a maximum deflection 1/240 of the span.

D. STRUCTURAL ATTACHMENTS:

1. TYPE A – MALLEABLE IRON CONCRETE INSERT: Concrete inserts shall be malleable iron and comply with MSS and FEDSPEC Type 18. Grinnell Fig. 282, Carpenter & Patterson Fig. 108, or equal.

2. TYPE B – SIDE BEAM BRACKET: Bracket shall be malleable iron and comply with MSS Type 34 and FEDSPEC Type 35. Grinnell Fig. 202, B–Line B3062, or equal.

3. TYPE C – MALLEABLE BEAM CLAMP WITH EXTENSION PIECE: Clamp and extension piece shall be malleable iron; tie rod shall be steel. Beam clamp shall comply with MSS and FEDSPEC Type 30. Grinnell Fig. 218 with Fig. 157 extension piece, B–Line B3054, or equal.

4. TYPE D – STEEL BEAM CLAMP WITH EYE NUT: Beam clamp and eye nut shall be forged steel. Configuration and components shall comply with MSS and FEDSPEC Type 28. Grinnell Fig. 292, Carpenter & Patterson Fig. 297, or equal.

5. TYPE E – FRAMING CHANNEL POST BASE: Post bases shall be carbon steel, of standard design manufactured by framing channel manufacturer. Single channel: Unistrut P2072A, B–Line B280, or equal. Double channel: Unistrut P2073A, B–Line B281, or equal.

6. TYPE F – WELDED BEAM ATTACHMENT: Beam attachment shall be carbon steel and comply with MSS and FEDSPEC Type 22. B–Line B3083, Grinnell Fig. 66, or equal.

7. TYPE G – WELDED STEEL BRACKET: Bracket shall be carbon steel and comply with MSS Type 32 and FEDSPEC Type 33 for medium welded bracket. Heavy welded bracket shall comply with MSS Type 33 and FEDSPEC Type 34.

8. TYPE H – CAST IRON BRACKET: Bracket shall be cast iron, Carpenter & Patterson Fig. 340, or equal.

9. TYPE J – ADJUSTABLE BEAM ATTACHMENT: Beam attachment shall be carbon steel, Carpenter & Patterson Fig. 151, B–Line B3082, or equal.

10. TYPE K – DOUBLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever bracket shall be a carbon steel double framing channel assembly, Unistrut P2542 through P2546, B–Line B297–12 through B297–36, or equal.

11. TYPE L – SINGLE CHANNEL BRACKET: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5. Cantilever bracket shall be a carbon steel single framing channel assembly, Unistrut P2231 through P2234, B–Line B198–6, B198–12, B196–18 and B196–24, or equal.

12. TYPE M – WALL MOUNTED CHANNEL: Wall channel shall be single channel framing channel as specified in paragraph 40 05 15–2.02 E.5.

13. TYPE N – PIPE STANCHION FLOOR ATTACHMENT: Baseplate shall be carbon steel with 1/2-inch minimum thickness. Anchor bolt holes shall be 1/16 inch larger than the anchor bolt diameter. The space between the baseplate and the floor shall be filled with nonshrink grout.

14. TYPE Q – CONTINUOUS CONCRETE INSERTS: shall be 1 5/8 by 1 3/8 Channel, cold formed 12 Ga. steel conforming to ASTM A 1001, stainless steel GR 33 or ASTM GR 33 A., hot dip galvanized conforming to ASTM A123 or A153, UNISTRUT P3200 Series, or approved equal.

E. ACCESSORIES:

1. HANGER RODS: Rods shall be stainless steel, threaded on both ends or continuous threaded and sized as specified.

2. WELDLESS EYE NUT: Eye nut shall be forged steel and shall comply with MSS and FEDSPEC Type 17. Eye nut shall be Grinnell Fig. 290, B–Line B3200, or equal.

3. WELDED EYE ROD: Eye rod shall be carbon steel with eye welded closed. Inside diameter of eye shall accommodate a bolt diameter 1/8 inch larger than the rod diameter. Eye rod shall be Grinnell Fig. 278, B–Line B3211, or equal.

4. TURNBUCKLE: Turnbuckle shall be forged steel and shall comply with MSS and FEDSPEC Type 13. Turnbuckle shall be Grinnell Fig. 230, B–Line B3202, or equal.

5. FRAMING CHANNEL: Framing channel shall be 1 5/8 inches square, roll formed, 12–gage carbon steel. Channel shall have a continuous slot along one side with in–turned clamping ridges. Single channel: Unistrut P1000, B–Line B22, or equal. Double channel: Unistrut P1001, B–Line B22A, or equal. Triple channel: Unistrut P1004A, B–Line B22X, or equal.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at hanger, support and guide locations on pipe requiring insulation. The shield shall consist of an insulation layer encircling the entire circumference of the pipe and a steel jacket encircling the insulation layer. The thermal shield shall be the same thickness as the piping system insulation specified in 40 27 05.09. The standard shield shall be used for hot systems and the vapor barrier shield shall be used for cold systems. Stainless steel band clamps shall be used where specified to ensure against slippage between the pipe wall and the thermal shield.

A. STANDARD SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Steel jacket and insulation shall be flush with end.

B. VAPOR BARRIER SHIELD:

1. INSULATION:

a. Hydrous calcium silicate, high density, waterproof
b. Compressive strength: 100 psi average
c. Flexural strength: 75 psi average
d. K factor: 0.38 at 100 degrees F mean
e. Temperature range: 20 degrees F to 500 degrees F

2. STEEL JACKET: Galvanized steel. Gage shall be the manufacturer's standard supplied for the given pipe size.

3. CONNECTION: Shield shall have butt connection to pipe insulation. Insulation shall extend 1 inch each side of steel jacket for vapor tight connection to pipe insulation vapor barrier.

2.04 PRODUCT DATA

The following information shall be provided in accordance with Section 01 33 00:

1. Hanger and support locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04.

2. Design Professional's reports as specified in paragraph 40 05 15–3.05.

PART 3—EXECUTION

3.01 HANGER AND SUPPORT LOCATIONS

The Contractor shall locate hangers and supports as near as possible to concentrated loads such as valves, flanges, etc. Locate hangers, supports and accessories within the maximum span lengths specified in the project manual to support continuous pipeline runs unaffected by concentrated loads.

At least one hanger or support shall be located within 2 feet from a pipe change in direction.

The Contractor shall locate hangers and supports to ensure that connections to equipment, tanks, etc., are substantially free from loads transmitted by the piping.

Where piping is connected to equipment, a valve, piping assembly, etc., that will require removal for maintenance, the piping shall be supported in such a manner that temporary supports shall not be necessary for this procedure.

Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.

3.02 INSTALLATION

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. Unless otherwise specified, there shall be no drilling or burning of holes in the building structural steel.
Hanger components shall not be used for purposes other than for which they were designed. They shall not be used for rigging and erection purposes.

The Contractor shall install items to be embedded before concrete is poured. Fasten embedded items securely to prevent movement when concrete is poured.

Embedded anchor bolts shall be used instead of concrete inserts for support installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during hanger and support installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Hanger and support components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Finished floor beneath Type N structural attachments and framing channel post bases shall be roughed prior to grouting. Grout between base plate and floor shall be free of voids and foreign material.

Baseplates shall be cut and drilled to specified dimensions prior to welding stanchions or other attachments and prior to setting anchor bolts.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 ADJUSTMENTS

The Contractor shall adjust hangers and supports to obtain required pipe slope and elevation. Shims made of material that is compatible with the piping material may be used. Stanchions shall be adjusted prior to grouting their baseplates.

3.04 ANCHOR BOLTS

Anchor bolts in new concrete shall be cast in place.

3.05 INSPECTION AND CERTIFICATION

The design professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15–1.02 B shall inspect the pipe hangers, support and restraint systems at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed pipe hanger, support and restraint system before the Owner assumes beneficial occupancy and provide written certification, <u>without any qualification statements</u>, that the installation conforms to the design professional's design <u>and</u> the Contract Document requirements as may be described in other Sections or on the drawings. All reports shall bear the Design Professional's seal and signature in accordance with the laws, rules and regulations of the state.

SECTION 40 05 15

APPENDIX A

PIPE HANGERS AND SUPPORTS TABLES

NOMINAL PIPE SIZE (INCHES)	SUPPORT ROD SIZE AND MAXIMUM LOAD PER ROD - SEE NOTES 1 AND 2		MAXIMUM SUPPORT SPACING (FEET)			
	ROD SIZE (INCHES)	MAX LOAD (POUNDS)	STEEL	COPPER	PLASTIC SEE NOTE 4	CAST IRON SEE NOTE 5
3/8 TO 3/4	3/8	610	5	5	CONTINUOUS	---
1	3/8	610	5	5	5	---
1-1/4	3/8	610	5	5	5	---
1-1/2	3/8	610	5	5	5	---
2	3/8	610	10	5	5	12 FEET FOR PRESSURE PIPE 10 FEET FOR SOIL PIPE
2-1/2	3/8	610	10	10	5	
3	3/8	610	10	20	5	
4	1/2	1130	10	20	5	
6	5/8	1810	15	20	5	
8	3/4	2710	15	20	5	
10	3/4	2710	20	---	5	
12	1	4960	20	---	10	
14	1	4960	20	---	---	
16	1	4960	20	---	---	
18	1	4960	20	---	---	
20	1-1/4	8000	20	---	---	
24	1-1/4	8000	20	---	---	
30	1-1/2	11630	20	---	---	

TABLE A - SUPPORT SPACING AND ALLOWABLE ROD LOADS

TABLE A NOTES:

1. DESIGN WEIGHT SHALL BE TWICE THE WEIGHT OF THE PIPE FULL OF WATER PLUS THE WEIGHTS OF VALVES, FITTINGS, INSULATING MATERIALS AND SUSPENDED HANGER COMPONENTS ON THE RUN OF PIPE BEING SUPPORTED.

2. ROD SIZES SHOWN ARE FOR THE SUPPORT OF A SINGLE PIPE. WHEN SUPPORTING MORE THAN ONE PIPE, ROD SHALL BE SIZED USING DESIGN WEIGHTS (SEE NOTE 1) TO DETERMINE THE TOTAL DESIGN LOAD. THE TOTAL DESIGN LOAD SHALL NOT EXCEED THE MAXIMUM LOADS IN THE TABLE ABOVE.

3. PIPE SHALL NOT HAVE POCKETS FORMED IN THE SPAN DUE TO SAGGING OF THE PIPE BETWEEN SUPPORTS CAUSED BY THE WEIGHT OF THE PIPE, MEDIUM IN THE PIPE, INSULATION, VALVES AND FITTINGS.

4. SPAN SHOWN IS FOR SCHEDULE 80 PVC PIPE AT 100°F. SPANS FOR OTHER PLASTICS, OTHER PVC PIPE SCHEDULES AND PIPES AT HIGHER TEMPERATURES SHALL BE SHORT- ENED IN ACCORDANCE WITH THE PIPE MANUFACTURER'S RECOMMENDATIONS. "CONTINUOUS" MEANS PIPE SHALL BE IN UNISTRUT OR SIMILAR CHANNEL.

5. PROVIDE A MINIMUM OF ONE HANGER PER PIPE LENGTH, WITHIN 4-INCHES OF THE BELL.

6. PIPE HANGER AND SUPPORT SELECTION SHALL BE IN ACCORDANCE WITH TABLE B (M2302) AND SPECIFICATION SECTION 15096.

TABLE B HANGER AND SUPPORT SELECTIONS

SYSTEM	INSULATION	PIPE ATTACHMENTS									BUILDING STRUCTURAL ATTACHMENTS			
		HORIZONTAL								VERTICAL	STEEL AND/OR MALL. IRON			
TEMP RANGE DEG F	NOTE 1	STEEL STRAPS	STEEL BANDS	STEEL CLAMPS	CAST IRON HANGING ROLLS	CAST IRON SUPPORTING ROLLS	STEEL TRAPEZES AND RACKS	THERMAL HANGER SHIELDS	STEEL OR CAST IRON STANCHIONS	STEEL RISER CLAMPS	INSERTS	BEAM CLAMPS	WELDED AND BOLTED ATTACHMENTS	BRACKETS
HOT A-1 120 TO 450	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	10					
HOT A-2 451 TO 750	COVERED	13	1	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	NONE	3	NONE	NONE	20, 21	NONE	NONE					
HOT A-3 OVER 750	COVERED	13	1	3 (ALLOY)	4, 5	8	20, 21	SEE SPEC	10	11, 12	NONE	C, D	F, J, M	B, G, H, K, L
	BARE	13	NONE	3 (ALLOY)	NONE	NONE	20, 21	NONE	NONE					
AMBIENT B 60 TO 119	COVERED	13	1, 2	3	4, 5	8	20, 21	SEE SPEC	9,10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2	3	4, 5	8	20, 21	NONE	9,10					
COLD C-1 33 TO 59	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	6, 7 13	1, 2, 3	3	4, 5	8	20, 21	NONE	10					
COLD C-2 -2 TO 32	COVERED	13	1, 2, 3	3	4, 5	8	20, 21	SEE SPEC	10	11, 12	A	C, D	F, J, M	B, G, H, K, L
	BARE	NONE	1, 2, 3	3	4, 5	8	20, 21	NONE	10					

TABLE B NOTES:

1. HANGERS ON INSULATED SYSTEMS SHALL INCORPORATE THERMAL HANGER SHIELDS.
2. HANGER AND SUPPORT SPACING SHALL BE IN ACCORDANCE WITH TABLE A (M2301).

TABLE C
SEISMIC RESTRAINT SPACING

NOM. PIPE SIZE	MAXIMUM SPAN BETWEEN BRACES		BRACE TYPE	MAXIMUM BRACE LENGTH
	LATERAL BRACE (FEET)	LONGITUDINAL BRACE (FEET)		
2	40	80	A1	9'-4"
2-1/2	40	80	A1	9'-4"
3	40	80	A1	9'-4"
4	40	80	A1	9'-4"
6	40	80	A1	9'-4"
8	40	40	A1	9'-4"
10	40	40	A1	9'-4"
12	40	40	A2	10'-0"
14	30	30	A2	10'-0"
16	25	25	A2	10'-0"
18	20	20	A2	10'-0"
20	16	16	A2	10'-0"
24	10	10	A2	10'-0"

(S) - STANDARD WALL

END OF SECTION

INDEX TO

SECTION 40 05 15.10 – SEISMIC RESTRAINTS FOR PIPING

SECTION 40 05 15.10

SEISMIC RESTRAINTS FOR PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies seismic restraints for bracing all piping systems specified in Section 40 27 05. This section does not include seismic restraints for fire sprinkler systems.

B. DEFINITIONS:

1. Longitudinal direction—direction parallel to the pipe axis.
2. Lateral direction—direction perpendicular to the pipe axis.

C. OPERATING CONDITIONS:

The seismic restraints specified in this section are provided to resist pipe movements and loads occurring as a result of an earthquake or other seismic event.

All piping systems shall be provided with seismic restraints conforming to governing state and local codes. Seismic restraints shall conform to the guidelines given in the SMACNA Seismic Restraint Manual for the Seismic Hazard Level consistent with the requirements of governing state and local codes. In case of conflict, the governing state or local code shall be followed.

D. RESTRAINT SELECTION:

1. The Contractor shall select, locate and provide seismic restraints for piping in accordance with this section. As set forth in Paragraph 40 27 05–1.01 A, this work shall be the product of a Design Professional retained by the Contractor.

2. The Contractor shall review the piping layout in relation to the surrounding structure and adjacent piping and equipment before selecting the restraint to be used at each point.

3. Seismic restraints may be omitted from the following installations:

    a. Gas piping less than 1–inch inside diameter.
    b. All other piping less than 2 1/2–inch inside diameter.

4. Piping systems shall not be braced to dissimilar parts of a building or to dissimilar building systems that may respond in a different mode during an earthquake. Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.

5. Restraints shall be sized to fit the outside diameter of the pipe, tubing, or, where specified, the outside diameter of insulation.

6. There shall be no contact between a pipe and restraint component of dissimilar metals. The contractor shall prevent contact between dissimilar metals when restraining copper tubing by the use of copper–plated, rubber, plastic or vinyl coated, or stainless-steel restraint components.

7. Branch lines shall not be used to brace main lines.

8. Seismic bracing shall not limit the expansion and contraction of the piping system.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction Manual of Steel Construction, Allowable Stress Design, 9th Edition
MFMA–2	Metal Framing Standards Publication
MFMA–101	Guidelines for the Use of Metal Framing
MSS SP–58	Pipe Hangers and Supports – Materials, Design and Manufacture

Reference	Title
MSS SP–69	Pipe Hangers and Supports – Selection and Application
MSS–SP–89	Pipe Hangers and Supports – Fabrication and Installation Practices
SMACNA	Seismic Restraint Manual—Guidelines for Mechanical Systems

B. DESIGN:

The seismic restraint system shall be designed by the Design Professional retained under Paragraph 40 27 05–1.01 A. Seismic restraint details shall be designed in conjunction with preparation of pipe system hangers and drawings specified in paragraph 40 27 05–2.04. All drawings and work product for the seismic restraint system shall bear the design professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

PART 2 – PRODUCTS

2.01 ACCEPTABLE PRODUCTS

Standard pipe restraints and components shall be manufactured by Carpenter & Patterson, B–Line, Kin–Line, ITT Grinnell, Michigan, Pipe Shields Incorporated, Superstrut, Unistrut, or equal. Pipe restraint materials, design, manufacture, installation, and application shall conform to the requirements of MSS SP–58, MSS–SP–69, MSS–SP–89, MFMA–1, and MFMA–101.

2.02 MATERIALS

A. GENERAL:

Unless otherwise specified, restraints manufactured of iron or steel, including braces, pipe and structural attachments, shall be hot–dip galvanized after fabrication. Nuts, bolts and washers, fittings and accessories, may be mechanically zinc–coated except for those subject to moisture or corrosive atmosphere, which are listed in paragraph 26 05 00–1.05 B; those compounds shall be type 304 stainless steel. Also listed in paragraph 26 05 00–1.05 B are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe supports, anchor and seismic brace components (not just fittings and accessories) shall be made of fiberglass.

2.03 THERMAL PIPE HANGER SHIELD

Thermal shields shall be provided at seismic restraint locations on pipe requiring insulation. Thermal pipe hanger shields shall be as specified in paragraph 40 05 15–2.03. Stainless steel band clamps shall be provided on thermal shields at longitudinal pipe restraint locations.

2.04 PRODUCT DATA

The following information shall be submitted:

1. Seismic restraint system drawings and calculations as specified in paragraph 40 05 15.10–1.02 B.

2. Seismic restraint locations and legend as specified in paragraph 40 05 15.10–3.01.

3. The Design Professional's reports and certification of final installation as specified in paragraphs 40 27 05–1.01 A and 40 05 15.10–3.03.

PART 3—EXECUTION

3.01 PIPE RESTRAINT LOCATIONS

The first seismic restraint on a piping system shall be located not more than 10 feet from the main riser, entrance to a building or piece of equipment.

Ductile and cast-iron pipe shall be braced on each side of a change in direction of 90 degrees or more. Joints in risers shall be braced or stabilized between floors.

No–hub and bell and spigot cast iron soil pipe shall be braced longitudinally every 20 feet and laterally every 10 feet.

Lateral bracing for one pipe section may also act as longitudinal bracing for the pipe section connected perpendicular to it, if the bracing is installed within 24 inches of the elbow or tee of the same size.

Seismic restraint locations and components shall be indicated on the piping layout drawings required by paragraph 40 27 05–2.04. The drawings shall bear a legend giving load information and restraint component selection at each restraint location and shall be sealed and signed by the Design Professional retained by the Contractor for design of the pipe hanger and support system under the provisions of paragraphs 40 27 05–1.02 C and 40 05 15.10–1.02 B.

3.02 INSTALLATION

Rod stiffener assemblies shall be used at seismic restraints for hanger rods over 6 inches in length. A minimum of two rod stiffener clamps shall be used on any rod stiffener assembly.

Lateral and longitudinal bracing shall be installed between 45 degrees above and 45 degrees below horizontal, inclusive, relative to the horizontal centerline of the pipe.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of AISC M011. There shall be no drilling or burning of holes in the building structural steel without approval of the Engineer.

Embedded anchor bolts shall be used instead of concrete inserts for seismic brace installations in new concrete areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during restraint installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations.

Restraint components in contact with plastic pipe shall be free of burrs and sharp edges.

Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05–1.01 A and 40 05 15.10–1.02 B shall inspect the seismic restraint system at not less than bi–weekly intervals during construction and furnish the Engineer with monthly reports. The Design Professional shall inspect the completed seismic control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

INDEX TO

SECTION 40 05 15.15 – EXPANSION CONTROL FOR PIPING

SECTION 40 05 15.15

EXPANSION CONTROL FOR PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies expansion control for the piping systems specified in paragraph 40 05 15.15-1.01 C. This section addresses pipe anchorage, pipe guides, and expansion control by either expansion joints or pipe deflection.

B. DEFINITIONS:

Term	Definition
Expansion joint	Any device containing one or more bellows used to absorb dimensional changes.
Main anchor	An attachment between a structure and a pipe which must withstand the full pipeline thrust due to pressure, pipe bending, pipe compression, flow, spring forces, pipe and contents weight and other pipe forces.
Intermediate anchor	An attachment between a structure and a pipe which withstands the same forces as a main anchor except the pressure forces.
Sliding anchor	An attachment between a structure and a pipe which absorbs forces in one direction while permitting motion in another.
Pipe guide	A device fastened to a structure, which permits the pipeline to move freely in only one direction, along the axis of the pipe.
Pipe section	That portion of pipe between two anchors.
Planar pipe guide	A device fastened to a structure, which permits transverse movement or bending of the pipeline in one plane.
Lateral direction	Direction perpendicular to the pipe axis
Longitudinal direction	Direction parallel to the pipe axis

C. OPERATING CONDITIONS:

Expansion control as specified in this section shall be provided to control pipe movements and loads occurring as a result of pipeline temperature changes.

Those piping systems listed in the following table shall be provided with expansion control conforming to good engineering practice.

Piping system	Minimum temperature, degrees F	Maximum temperature, degrees F
A, AA, BA, CA, IA, SA	17 (exterior –20)	300 (exterior 200)
CS, DS, LSG, MSG (and combinations)	30 (exterior –20)	120
EE	-20	1000
GRR/S	-20	200
HW, HRR/S	70	230
Unlisted Piping (exterior)	-20	120
Unlisted Piping (interior)	30	120

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AISC Manual of Steel Construction	American Institute of Steel Construction, Manual of Steel Construction, Allowable Stress Design - 9th Edition
EJMA-93	Standards of the Expansion Joint Manufacturers Association, Inc., Sixth Edition, 1993
EJMA-85	A Practical Guide to Expansion Joints, Copyright 1985, Expansion Joint Manufacturers Association, Inc.

B. DESIGN:

The expansion control system shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05-1.01A. Expansion control details shall be designed in conjunction with preparation of pipe system hangers and seismic restraint systems drawings specified in paragraph 40 27 05-2.04. The resulting drawings and work product for the expansion control system shall bear the Design Professional's registration seal and signature. The requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. DESIGN GUIDELINES:

The Design Professional shall use the following guidelines in preparation of the designs and calculations specified in paragraph 40 05 15.15-1.02 B:

1. The difference between the minimum and maximum temperatures listed in the table in paragraph 40 05 15.15-1.02 C shall be used for calculating pipe expansion.

2. Published coefficients of thermal expansion for pipe materials shall be used for the listed temperature range. The source of the coefficients of expansion used in the calculations shall be included with the information provided as Product Data.

3. Expansion control systems shall be designed for maximum reliability. Unless otherwise indicated on the Drawings, "L", "U", or "Z" bends shall be employed to control expansion in preference over expansion joints.

4. Expansion control systems using pipe bends shall be designed to limit bending stress in the pipe associated with deflection at the worst-case temperature difference. The maximum allowable bending stress shall be 1/3 of the yield stress for the pipe material. If loading conditions or uncertainties warrant, a lower allowable stress value shall be used. A recognized pipe bending stress calculation method and documentation supporting its use shall be provided as Product Data.

5. Expansion control design for expansion joints shall conform to the guidelines given in the Standards of The Expansion Joint Manufacturers Association, Inc. (EJMA).

6. If the Design Professional chooses to use expansion control or pipe support methods that involve higher loadings on the structure than are specified and/or shown on the drawings, the Construction Manager shall be notified in the submittal required in paragraph 40 27 05-2.04. The requested loads shall be listed and the Construction Manager will redesign the structure as necessary at the Contractor's expense.

7. The test pressures listed in the PIPESPEC sheets shall be used when calculating pressure forces.

8. Pipe guides or planar pipe guides shall be provided to control the movement of pipes when "L", "U", or "Z" bends are used for expansion control. The guides shall be located as indicated in EJMA standards. An alternative recognized standard may be used for this purpose only upon approval by the Construction Manager.

9. For piping systems with potentially large loads, recommended main anchor locations are shown on the drawings. Intermediate anchors shall be provided as needed. Maximum forces that the structure can withstand at the main anchor points are noted on the drawings. Anchors shall be designed to attach to the structure and solidly to the pipe. Pipe clamps or U-bolts are not allowed unless they are designed to withstand the forces imposed upon the anchor and have stops welded to the pipe so that the pipe cannot slip in the anchor.

10. Anchors and guides shall be coordinated with the pipe support systems specified in Section 40 05 15 and seismic restraints specified in Section 40 05 15.10.

11. The design of the expansion control, pipe support and seismic restraints for the listed piping systems shall be integrated to provide maximum flexibility for maintenance access to equipment, appurtenances such as valves etc., and to the pipe itself.

12. The piping layout indicated shall be reviewed in relation to, surrounding structures, adjacent piping and equipment before selecting the anchors, guides, and expansion control method to be used at each point.

13. There shall be no metal-to-metal contact between a pipe and restraint component of dissimilar metals.

14. Branch lines shall not be used to anchor main lines.

15. For elevated pipe sections, fabricated support frames or other appropriate structures shall be designed to withstand the specified loads plus gravity and seismic loads. The supports shall be designed to provide access to equipment, walkways, gates, and other piping.

1.03 SUBMITTALS

The following information shall be submitted for approval:

1. Expansion control schedules as specified in paragraph 40 05 15.15-3.01.

PART 2 - PRODUCTS

2.01 MATERIALS

Unless otherwise specified, anchors, and guides shall be manufactured of iron or steel, including braces, pipe and structural attachments, and shall be hot-dip galvanized after fabrication. Supports cast integrally with cast iron fittings are specifically prohibited for use in any application where shear forces may be imposed on the support. Structural anchors may be fabricated from structural steel and coated. Nuts, bolts and washers may be zinc-plated except for those subject to moisture or corrosive atmosphere, as specified in paragraphs 26 05 00-1.05 B and C, which shall be Type 304 stainless steel. Also listed in paragraph 26 05 00-1.05 C are corrosive areas specifically requiring fiberglass materials. In those areas, all pipe support, anchor and brace components (not just fittings and accessories) shall be made of fiberglass.

2.02 PRODUCT DATA

The following product data shall be Submitted for Approval:

1. Anchor bolt calculations.

2. The Design Professional's reports and final certification, as specified under paragraph 40 05 15.15-3.03.

PART 3 - EXECUTION

3.01 EXPANSION CONTROL SCHEDULES

A. GENERAL:

Anchor, guide, and expansion joint locations shall be indicated on the piping layout drawings required by paragraphs 40 27 05-2.04 and 40 05 15.15-1.02 B. In addition, schedules shall be prepared as specified below.

B. ANCHORS:

The anchor schedule shall list as a minimum:

1. Anchor Point Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Forces
6. Load, pounds
7. Direction
8. Anchor Description
9. Remarks

C. GUIDES:

The guide schedule shall list as a minimum:

1. Guide Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Guide Description
6. Remarks

D. EXPANSION JOINTS:

The expansion joint schedule shall list as a minimum:

1. Expansion Joint Label
2. Pipe Size and Service
3. Contract Drawing No.
4. Layout Drawing No.
5. Movement, inches
   a--Lateral movement
   b--Compression movement
   c--Extension movement
   d--Angular movement
6. Maximum Spring Force, pounds
7. Test Pressure, psig
8. Pressure Force, pounds
9. Total Forces
10. Load, pounds
11. Direction
12. Expansion Joint Description
13. Special Features
14. Remarks

3.02 INSTALLATION

The Contractor shall install the expansion control system in accordance with the drawings required in paragraph 40 05 15.15-1.02 B.

Welded and bolted attachments to the building structural steel shall be in accordance with the requirements of the AISC Manual of Steel Construction. There shall be no drilling or burning of holes in the building structural steel without approval of the Construction Manager.

Unless otherwise specified, embedded anchor bolts shall be used instead of concrete inserts, wedge anchors, expansion anchors, adhesive, or other non-embedded type of anchor for expansion control installations in areas below water surface or normally subject to submerging.

The Contractor shall install thermal pipe hanger shields on insulated piping at required locations during guide installation. Butt joint connections to pipe insulation shall be made at the time of insulation installation in accordance with the manufacturer's recommendations. Anchors shall be directly connected to the pipe by welding or another acceptable, positive means.

Components in contact with plastic pipe shall be free of burrs and sharp edges.
Rollers shall roll freely without binding.

Plastic or rubber end caps shall be provided at the exposed ends of all framing channels that are located up to 7 feet above the floor.

3.03 INSPECTION AND CERTIFICATION

The Design Professional retained by the Contractor under the provisions of paragraphs 40 27 05-1.01 A and 40 05 15.15-1.02 B shall inspect the completed expansion control system at not less than bi-weekly intervals during construction and furnish the Construction Manager with monthly reports. The Design Professional shall inspect the completed expansion control system before the Owner assumes beneficial occupancy and provide written certification in accordance with Section 40 05 15 requirements.

END OF SECTION

INDEX TO

SECTION 40 27 01.02 – STEEL PIPE

SECTION 40 27 01.02

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies steel pipe and fittings.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
ANSI B16.9	Factory–Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket–Welding and Threaded
ASTM A36/A36M	Structural Steel
ASTM A47	Ferritic Malleable Iron Castings
ASTM A53	Pipe, Steel, Black and Hot–Dipped, Zinc–Coated Welded and Seamless
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106 REV A	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures

Reference	Title
ASTM A283/A283M REV A	Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes and Bars
ASTM A536	Ductile Iron Castings
ASTM A570/A570M	Hot–Rolled Carbon Steel Sheet and Strip, Structural Quality
ASTM A572/A572M REV B	High Strength Low Alloy Columbium–Vanadium Steels of Structural Quality
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger— Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. Through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA M11	Steel Pipe—A Guide for Design and Installation
SSPC–SP10	Near–White Blast Cleaning

B. TESTING:

Factory testing shall conform to the requirements of ASTM A53, ASTM A106, or AWWA C200 as applicable.

PART 2 – PRODUCTS

2.01 PIPE MATERIALS

Steel pipe and fittings shall be provided in accordance with ASTM A53, ASTM A106, or AWWA C200 as specified in Section 40 27 05, Piping Systems.

Steel for pipe fabricated to meet requirements of AWWA C200 shall conform to the requirements of ASTM A36, ASTM A572, Grade 42, ASTM A570, Grades 33 and 36, or ASTM A283, Grade D. Steel for ASTM A53 and ASTM A106 pipe shall be Grade B.

2.02 PIPE MANUFACTURE

Unless otherwise specified, ASTM A53 pipe shall be Type E, electric resistance welded or Type S, seamless pipe as specified in Section 40 27 05. The minimum wall thickness for ASTM A53 or ASTM A106 pipe shall be Schedule 40 for pipe 10 inch diameter and less and 3/8 inch for pipe 12 inch through 24 inch diameter. Increased shell thickness shall be provided where specified.

AWWA C200 pipe shall be straight or spiral seam. The minimum wall thickness shall be 7 gage for pipe 6 inch through 24 inch diameter and 1/4 inch for pipe 26 inch diameter and larger. Increased shell thickness shall be provided where specified.

2.03 CONNECTIONS

Connections shall be as specified in Section 40 27 05 and shall conform to Section 40 27 05.04. Coating for buried connections shall be as specified in paragraph 40 27 05.04–2.06.

2.04 FITTINGS AND APPURTENANCES

Malleable iron threaded fittings and appurtenances shall conform to the requirements of ASTM A47 or ASTM A197, ANSI B16.3.

Unless otherwise specified, steel fittings and appurtenances shall conform to the requirements of ASTM A234, ASTM A105, or ANSI B16.11; and fabricated steel fittings and appurtenances shall conform to AWWA C208.

Fittings for grooved end piping systems shall be full flow cast fittings, steel fittings, or segmentally welded fittings with grooves or shoulders designed to accept grooved end couplings. Cast fittings shall be cast of ductile iron conforming to ASTM A536 or malleable iron conforming to ASTM A47. Standard steel fittings, including large size elbows, shall be forged steel conforming to ASTM A106. Standard segmentally welded fittings shall be fabricated of Schedule 40 carbon steel pipe.

Unless otherwise specified, all fittings shall be rated for pressure and loadings equal to the pipe.

2.05 PIPE LINING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be lined with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

The lining shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. CEMENT MORTAR:

Where specified, pipe and fittings shall be lined with cement mortar as specified in AWWA C205. Fittings and specials larger than 24 inches, not fabricated from centrifugally lined straight sections, shall require 2–inch by 4–inch by 13–gage self–furring wire mesh reinforcement for hand–applied lining.

C. HIGH TEMPERATURE SERVICE EPOXY:

Where specified, steel pipe and fittings shall be epoxy lined with not less than 10 mils of epoxy suitable for temperatures of 225 degrees F. Epoxy lining shall be 3M Scotchkote 306, Porter MCR 65 High Solids Epoxy, or equal. Surfaces shall be prepared in accordance with SSPC–SP 10 Near White Blast Cleaning, and the lining applied as recommended by the manufacturer.

D. GLASS LINING:

Where specified, pipe and fittings shall be glass lined with a dual layer coating system of vitreous material to a minimum thickness of 10 mils. Glass lining shall provide continuous coverage as tested by a low voltage holiday detector with only isolated voids permitted due to casting anomalies. Voids, other than isolated pinholes, shall be cause for rejection.

Pipe and fittings shall have all internal welds ground smooth and any voids or slag holes ground out, rewelded and ground smooth.

Glass lining shall be Ferrock MEH–32, Vitco SG–14, or equal.

2.06 PIPE COATING

A. EPOXY:

Unless otherwise specified, pipe and fittings shall be coated with a liquid epoxy as specified in AWWA C210 with the following exceptions:

1. No coal tar products shall be incorporated in the liquid epoxy.

2. The curing agent may be an amidoamine as well as the other curing agents listed in AWWA C210.

   The coating shall be applied to a minimum thickness of 16 mils in not less than two coats.

B. POLYETHYLENE TAPE:

Where specified, pipe and fittings shall be coated and wrapped with prefabricated multilayer cold applied polyethylene tape coating in accordance with AWWA C214. The coating application shall be a continuous step operation in conformance with AWWA C214, Section 3. The total coating thickness shall be not less than 50 mils for pipe 24 inches and smaller and not less than 80 mils for pipe 26 inches and larger.

2.07 FUSION EPOXY COATING AND LINING

Where specified, steel pipe and fittings shall be fusion epoxy coated and lined. The fusion epoxy coating shall be 3M Scotchkote 203, or equal. Surface preparation shall be in accordance with SSPC–SP 10 Near White Blast Cleaning. The application method shall be by the fluidized bed method and shall attain 12 mils minimum dry film thickness.

Field welds, connections and otherwise damaged areas shall be coated and patched according to the manufacturer's instructions with 3M Scotchkote 306.

2.08 JOINT GASKETS

Joint gaskets shall be as specified in Section 40 27 05.02.

2.09 PRODUCT DATA

The following information shall be submitted for approval:

1. Affidavits of Compliance with AWWA C200, ASTM A53, or ASTM A106 as applicable.

2. Contractor's layout drawings as specified in paragraph 40 27 05–2.04.

PART 3—EXECUTION

3.01 INSTALLATION

A. GENERAL:

Pipe shall be installed in accordance with AWWA M11, Chapter 16. Welded joints shall be in accordance with AWWA C206 and Section 40 27 05.04.

Sleeve–type mechanical pipe couplings shall be provided in accordance with AWWA M11 and paragraph 40 27 05.04–2.02 A.

Pipe lining and coatings at field joints shall be applied as specified in paragraphs 40 27 01.02–2.05 and 2.06.

Unless otherwise specified, buried mechanical couplings and valves shall be field coated as specified in paragraph 40 27 05.04–2.06.

B. ANCHORAGE:

Anchorage shall be provided as specified. Calculations and drawings for proposed alternative anchorage shall be submitted in accordance with Section 01300.

3.02 TESTING

Hydrostatic testing shall be in accordance with Section 4 of AWWA C600 except that test pressures and allowable leakage shall be as listed in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.03 – PLASTIC PIPE

SECTION 40 27 01.03

PLASTIC PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies polyvinylchloride, chlorinated polyvinylchloride, polyethylene, and polypropylene pipe and fittings.

B. PIPE DESIGNATIONS:

For use in the Piping System Specification Sheets (PIPESPEC) in Section 40 27 05 and in this section, the following plastic pipe designations are defined:

Designation	Definition
PVC	Polyvinylchloride
CPVC	Chlorinated polyvinylchloride

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2464	Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	Socket–Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2564	Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
ASTM D2657	Heat–Joining Polyolefin Pipe and Fittings
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D4101	Propylene Plastic Injection and Extrusion Materials
ASTM F402	Safe Handling of Solvent Cements and Primers Used for Joining Thermoplastic Pipe and Fittings
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F438	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40
ASTM F439	Socket–Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

PART 2 – PRODUCTS

2.01 PVC PIPE

A. PRESSURE PIPE:

PVC material for pipe and fittings shall conform to ASTM D1784, Class 12454–B. Pipe and fittings shall either be in accordance with ASTM D1785 or shall conform to ASTM D2241 for standard dimension ratios: 160 psi pipe—SDR 26; 200 psi pipe—SDR 21;

250 psi—SDR 17. Pressure rating for pipe shall be in excess of test pressure specified in Section 40 27 05. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 PVC socket type fittings shall conform to ASTM D2467. Schedule 40 PVC fittings shall conform to ASTM D2466. PVC solvent weld cement for socket connections shall meet the requirements of ASTM D2564. Schedule 80 PVC threaded fittings shall conform to ASTM D2464. Fittings for gasketed pipe shall be ductile iron or steel push–on IPS–sized pressure fittings rated for use with the specified class of PVC pipe. Unless otherwise specified, fittings shall be lined and coated in accordance with Section 33 05 01.03 as applicable.

B. NONPRESSURE PIPE:

1. GRAVITY SEWER PIPE: PVC material for sewer pipe and fittings shall conform to Class 12454–B, as defined in ASTM D1784. Pipe and fittings shall meet the requirements of ASTM D3034 for SDR 26. Neoprene gaskets with push–on joints shall conform to ASTM F477.

2. DRAIN, WASTE AND VENT PIPE: PVC material for drain waste and vent (DWV) pipe and fittings shall conform to Class 12454–B, ASTM D1784. Pipe and fittings shall conform to ASTM D2665. Unless otherwise specified, connections shall be solvent weld. Connections to traps, closet flanges, and nonplastic pipe shall be with approved adapter type fittings designed for intended use. Solvent weld cement for socket connections shall meet requirements of ASTM D2564.

2.02 CPVC PIPE

CPVC material for pipe and fittings shall conform to ASTM D1784, Class 23447–B. Pipe and fittings shall be in accordance with ASTM F441. Neoprene gaskets with push–on joints shall conform to ASTM F477.

Schedule 80 CPVC socket type fittings shall conform to ASTM F439. Schedule 40 CPVC socket type fittings shall conform to ASTM F438. CPVC solvent weld cement for socket connections shall meet the requirements of ASTM F493. Schedule 80 CPVC threaded type fittings shall conform to ASTM F437.

2.03 PRODUCT DATA

The following information shall be provided:

1. Manufacturer's certificates of compliance with the specified standards and Contractor's layout drawings.

PART 3 – EXECUTION

3.01 INSTALLATION

PVC pipe 3 inches in diameter and smaller shall be joined by means of socket fittings and solvent welding in conformance with ASTM F402. Solvent–cemented joints shall be made in strict compliance with the manufacturer's/supplier's instructions and recommended procedures. Unless otherwise specified, PVC pipe 4 inches in diameter and greater shall be joined by means of gasketed push–on joints and steel or ductile iron push–on or mechanical joint fittings. Fittings shall be lined and coated as specified in Section 33 05 01.03. Unless otherwise specified, PVC and CPVC piping exposed to sunlight shall be painted.

Connections to different types of pipe shall be by means of flanges, specified adapters or transition fittings. Where sleeve type couplings are used, both shall be uniformly torqued in accordance with pipe manufacturer's recommendation. Foreign material shall be removed from the pipe interior prior to assembly.

Unless otherwise specified, PE pipe and fittings 4 inch diameter and smaller shall be joined by means of thermal socket fusion and pipe 6 inch and larger by thermal butt fusion. Butt–fusion joining of the pipes and fittings shall be performed with special joining equipment in accordance with procedures recommended by pipe manufacturer. Tensile strength at yield of butt–fusion joints shall not be less than pipe. Flanged adapters shall be provided for connection to valves and where specified.

3.02 TESTING

Testing of plastic piping shall be as specified in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.04 – COPPER PIPING

SECTION 40 27 01.04

COPPER PIPING

PART 1–GENERAL

1.01 DESCRIPTION

This section specifies copper piping, tubing, couplings and fittings.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.22	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32	Solder Metal
ASTM B88	Seamless Copper Water Tube

PART 2 – PRODUCTS

2.01 COPPER TUBING

Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn, where used in exposed service and Type K, annealed or drawn for buried service.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

Unless otherwise specified, couplings and fittings for copper tubing 1/2 inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or equal.

Couplings and fittings for copper tubing larger than 1/2–inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

Solder to be used in copper piping shall be ASTM B32, Alloy Grade Sn95 or Silvabrite 100.

2.04 PRODUCT DATA

Contractor's layout drawings and catalog data demonstrating compliance with this specification and giving full description of the copper piping shall be provided in accordance with contract submittal requirements.

PART 3 – EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS:

All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS:

Takedown couplings shall be screw union type and shall be provided in accordance with paragraph 40 27 05.04–3.03.

C. DIELECTRIC PROTECTION:

Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the Contractor shall provide dielectric protection in accordance with Section 40 27 05.04– 3.05.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

The installation, cleaning, disinfection, and testing of copper piping shall be as specified in Section 40 27 05.

END OF SECTION

INDEX TO

SECTION 40 27 01.05 – STAINLESS STEEL PIPING

SECTION 40 27 01.05

STAINLESS STEEL PIPING

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies stainless steel pipe and fittings.

B. TYPES OF SERVICE:

Stainless steel piping specified in this section shall be used for ALL Aeration piping.

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, 250, and 800
ANSI B16.11.80	Forged Steel Fittings, Socket Welding and Threaded.
ANSI B31.1	Power Piping
ANSI B36.19M	Stainless Steel Pipe

Reference	Title
ASME Section IX (1989)	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A182/A182M	Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
ASTM A193/A193M	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High-Temperature Service
ASTM A240	Heat-Resisting Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat-Resisting Steel Bars and Shapes
ASTM A312/A312M	Seamless and Welded Austenitic Stainless Steel Pipes
ASTM A320/A320M	Alloy Steel Bolting Materials for Low-Temperature Service
ASTM A403/A403M	Wrought Austenitic Stainless Steel Piping Fittings
ASTM A409/A409M	Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service
ASTM A480/A480M	General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip
ASTM A774/A774M	As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
ASTM A778	Welded, Unannealed Austenitic Stainless Steel Tubular Products

B. QUALIFICATIONS:

All shop fabricated stainless steel pipe and fittings shall be furnished by a single manufacturer who is experienced and qualified in the manufacture and fabrication of the items to be furnished. The pipe and fittings shall be shop-fabricated and field-installed in accordance with common industry wide practices and methods and shall comply with these specifications.

Only weld procedures which have been qualified under ASME Section IX and only welders who have successfully completed performance qualification tests per ASME Section IX on these qualified procedures shall be utilized.

C. TESTING:

Factory testing shall conform to the requirements of ASTM A312, ASTM A409 HT-0, or ASTM A778, depending on the size and type of stainless steel pipe provided.

1.03 SUBMITTALS

The following information shall be provided in accordance with Section 0133 00 Submittal:

1. 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. A check mark 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.*

2. Shop fabrication drawings showing details of materials, piping, fittings, couplings, dielectric connections, joint locations and details, types and locations of supports.

3. Other data necessary to show conformance of the complete piping system to these specifications.

PART 2 – PRODUCTS

2.01 PIPE

Unless otherwise specified, stainless steel pipe 2-1/2 inches and smaller shall be Type 304L, seamless, threaded joints conforming to ASTM A312. The minimum wall thickness shall be Schedule 40S.

Unless otherwise specified, stainless steel piping 3 inches and larger shall be manufactured from ASTM A240 annealed and pickled sheets and plates, Type304L, in accordance with ASTM A778 or ASTM A409 HT-0. The minimum wall thickness shall be Schedule 5S. Only extra-low carbon (ELC) materials with 0.030 percent maximum carbon shall be used

2.02 FITTINGS

Unless otherwise specified, stainless steel fittings, 2-1/2-inches and smaller, shall be ASTM A403, of the same material and pressure rating as the pipe, threaded long radius with dimensions conforming to ANSI B16.11.

Unless otherwise specified, stainless steel fittings, 3-inch and larger, shall be butt-weld type manufactured in accordance with ASTM A774 of the same material and in the same thicknesses as the pipe. Reducers shall be straight tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated from pipe.

2.03 JOINTS

Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-weld joints or flanges. Unless otherwise specified, flanged joints shall be Van Stone joints made up of stainless steel slip-on type rolled-angle face rings and ductile iron backup flanges drilled to ANSI B16.1, Class 125 standard. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to which it is welded, and it shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes. For submerged joints, backup flanges shall be stainless steel plate flanges. The backup flanges shall be supplied with the following nominal thicknesses.

Nominal pipe size, inches	Flange thickness, inches
3	1/2
4	9/16
6-10	5/8

2.04 COUPLINGS

A. GENERAL:

Fabricated stainless steel piping shall be shop-prepared for pipe couplings where specified. Unless otherwise specified, couplings shall be arched-band or grooved type.

B. SLEEVE TYPE:

Sleeve type couplings, where specified, shall be of standard steel construction as specified in paragraph 40 27 05.04-2.02 A. Pipe shall be plain-end with external weld beads ground smooth to ensure proper gasket seating. For pressure pipe lines, sleeve coupling joints shall be restrained by the use of harness rods connecting across the joint to flange lugs on adjacent flange joints. Where no adjacent flange joints exist, stainless steel harness lugs shall be welded to the pipe to receive the harness rods.

C. ARCHED-BAND TYPE:

Arched-band type couplings shall be stainless steel of the same material and wall thickness as the pipe and shall be Depend-O-Lok type as manufactured by Brico or equal. Couplings shall be Fixed--FxF, Expansion--ExE, or Fixed by Expansion--FxE as specified or as required. The pipe shall be plain-end with external weld beads ground smooth and with S.S. restraining rings shop-welded to the piping for fixed type couplings.

D. GROOVED-END TYPE:

Grooved-end or split type couplings shall be malleable iron or ductile iron as specified in paragraph 40 27 05.04-2.02 C except that submerged couplings shall be the same material as the pipe. The pipe ends shall be roll-grooved to the coupling manufacturer's specifications. Where roll grooving is impractical, the pipe shall have heavy-wall machine-grooved pipe nipples or machined ring collars fully welded to the pipe or fitting. Nipples shall be taper-bored to the I.D. of the adjoining pipe to allow full-weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.

E. EXPANSION TYPE:

Unless otherwise specified, expansion couplings shall be the flanged rubber arch type as specified in Section 40 27 05.06. Pipe flanges shall be provided for these couplings.

2.05 THREADED CONNECTIONS

Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182 or ASTM A276, shop welded to the pipe at the locations specified.

2.06 GASKETS

Unless otherwise specified, gaskets shall be as specified in the PIPESPECS and in paragraph 40 27 05.04-2.03. For air lines, gaskets shall be neoprene or EPDM suitable for use at temperatures to 240 degrees F.

2.07 BOLTS

Bolts, nuts, and washers for stainless steel flange assemblies and stainless-steel couplings shall be the same material, conforming to ASTM A320 for low-temperature service and ASTM A193 and ASTM A194 for high-temperature service. Bolts, nuts and washers for other couplings shall be as specified in referenced paragraphs for the couplings.

2.08 PIPE SUPPORT SYSTEMS

Unless otherwise specified, all hangers, rods, structural attachments, and other components of support systems for stainless steel pipe shall be of the same materials as the pipe and conform to Section 40 05 15.

2.09 FINISH

After all shop operations have been completed, pipe and fittings shall be pickled and passivated in manufacturer's plant and scrubbed and washed until discoloration and possible iron picked up from manufacturing process are removed. The standard finish for 16-gage through 8-gage material shall be No. 1 or 2B per ASTM A480; 3/16-inch and heavier plate material shall be No. 1 mill finish or better per ASTM A480.

2.10 PRODUCT DATA

The following information and data shall be submitted for approval:

1. Certifications specified in the following documents:

   ASTM A403, paragraph 14.1
   ASTM A774, paragraph 14.1
   ASTM A778, paragraph 14.1
   ASTM A409, paragraph 17.1

2. Test results specified in paragraph 40 27 01.05-1.02 C.

3. Names and qualification records of proposed welders.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1. All pipe threads shall be lubricated with Teflon tape.

3.02 WELDING

A. GENERAL:

Piping with wall thickness up to 11 gage (0.120 inch) shall be welded with the TIG (GTAW) process. Unless otherwise specified, heavier walls shall be properly beveled and have a root pass with the TIG (GTAW) process followed by subsequent passes with the TIG (GTAW), MIG (GMAW), or Metallic Arc (SMAW) process. Filler wire of ELC grades only shall be added to all welds to provide a cross section at the weld equal to or greater than the parent metal. Weld deposit shall be smooth and evenly distributed and have a crown of no more than 1/16 inch on the I.D. and 3/32 inch on the O.D. of the piping. Concavity, undercut, cracks, or crevices shall not be allowed. Butt welds shall have full penetration to the interior surface, and inert gas shielding shall be provided to the interior and exterior of the joint. Excessive weld deposits, slag, spatter, and projections shall be removed by grinding. Welds on gasket surfaces shall be ground smooth.

B. FIELD WELDING:

Field welding shall be minimized to the greatest extent possible by use of couplings and prefabrication of pipe systems at the factory. Pipe butt welds may be performed at the job site, providing the but welds are performed only with an inert gas shielded process and that other applicable specified welding requirements are rigidly adhered to.

All residue, oxide, and heat stain is to be removed from any type of field weld and the affected areas adjacent by the use of stainless steel wire brushes, followed by cleaning with an agent such as Eutectic Company's "Eucleen," or equal, followed by complete removal of the agent.

C. PREPARATION OF SURFACES TO BE WELDED:

Surfaces of joints to be welded shall be free from mill scale, slag, grease, oil, paint, rust, and other foreign material. Joints to be welded shall be wire-brushed with stainless steel wire brushes and precisely fitted before welding.

D. WEATHER CONDITIONS:

Welding shall be done only when the surfaces are completely free of any moisture. Welding of the pipe shall not be done during periods of high winds or rain unless the areas being welded are properly shielded.

E. TACK WELDS, CLIPS, AND OTHER ATTACHMENTS:

Nicks, gouges, notches, and depressions in the base metal in the area of the joint shall be repaired before the joint weld is made. Tack welds, clips, and other attachments shall be removed and defects repaired, except where the tack welds occur within the weld area and these tack welds do not exceed the size of the completed weld. Cracked tack welds shall be removed. Areas to be repaired shall be ground to clean metal and then repaired by building up with weld metal. The repaired areas shall be ground smooth to form a plane surface with the base metal.

F. DEFECTS AND REPAIRS:

Welds with cracks, slag inclusions, porosity, undercutting, incomplete penetration, or which are otherwise deficient in quality or made contrary to any provisions of these specifications shall be removed by chipping or grinding throughout their depth to clean base metal. Calking or peening of welds to correct defects shall not be done. Welds found deficient in dimension but not in quality shall be enlarged by additional welding after thoroughly cleaning the surface of previously deposited metal and the adjoining plate. Weld deposits, slag, weld spatter, and projections into the interior of the pipe shall be removed by grinding.

3.03 MARKING, SHIPPING, AND STORAGE

All pipe, fittings, and fabrications shall be properly marked with type, gage, and heat number. All fabricated piping shall have openings plugged and flanges secured for storage and/or transport after fabrication. All fabricated piping shall be piece-marked with identifying numbers or codes which correspond to the Contractor's layout and installation drawings. The marks will be located on the spools at opposite ends and 180 degrees apart. Pipe spools shall be loaded and blocked and lagged as necessary to ensure protection from damage during shipping. Stainless steel pipe and fittings shall be stored per manufacturer's recommendation. Dents, gouges, and scratches in stainless steel pipe and fittings are not acceptable and are reason for rejecting pipe and fittings.

3.04 FABRICATION/INSTALLATION REQUIREMENTS

The piping supplier during manufacturing, fabricating and handling stages, and 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 nonferrous or stainless steel or rubber-lined. Nylon slings or straps shall be used for handling stainless steel piping. Contact with ferrous items may cause rusting of iron particles embedded in the piping walls. After installation, the Contractor shall wash and rinse all foreign matter from the piping surface. All welded joints shall be treated with a pickling solution, brushed with stainless steel wire brushes and rinsed clean. If rusting of embedded iron occurs, the Contractor shall pickle the affected surface with Oakite Deoxidizer SS, or equal, scrub with stainless steel brushes, and rinse clean.

3.05 COATINGS

After installation, the Contractor shall paint all steel or iron flanges, couplings, and appurtenances. 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 hot water and rinsed clean.

END OF SECTION

INDEX TO

SECTION 40 27 05 – PIPING SYSTEMS

SECTION 40 27 05

PIPING SYSTEMS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

1. General – This section specifies systems of process piping and general requirements for piping systems. Detailed specifications for the components listed on the Piping System Specification Sheets are found in other sections of Division 40 and 33. This section shall be used in conjunction with those sections.

   Most of the valves are provided on this project by Kubota as part of their equipment package. The valves listed in this specification are for valves that are not part of their package. The contractor shall coordinate with Kubota to confirm the pipe connections to the valves supplied in their package.

   Contractor shall provide all piping and ancillary devices as shown, specified and required to provide a fully functional system.

2. Contractor Design of Piping Systems – In addition to materials, labor, and plant required to construct piping systems, Contractor shall provide professional engineering services ("Design Professional") for the design and inspection of piping systems work.

   The Contractor shall provide the final design, inspection, and certification for the piping supports, seismic restraints, and provisions for control of dynamic forces and pipe expansion for buried and exposed piping on this project. Pipe supports are specified under Section 40 05 15. Seismic restraints are specified under Section 40 05 15.10. Pipe expansion control systems are specified under Section 40 05 15.15. The design of these systems shall be the product of a professional engineer currently licensed to practice in the State of South Carolina retained by the Contractor. The professional engineer (hereinafter and in all referenced sections the "Design Professional") shall obtain and maintain professional liability insurance in the amount of $1,000,000 aggregate to be in effect for duration of this project plus one year. The Design Professional shall have not less than five years experience in the type of piping support, seismic restraint and expansion control design work required for this project. This requirement, however, shall not be construed as relieving the Contractor of overall responsibility for this portion of the work. Documentation demonstrating qualifications and insurance shall be submitted.

B. Definitions:

Pressure terms used in Section 40 27 05 and elsewhere in Division 40 are defined as follows:

1. Maximum: The greatest continuous pressure at which the piping system operates.

2. Test: The hydrostatic pressure used to determine system acceptance.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ANSI A13.1	Scheme for the Identification of Piping Systems
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ANSI B16.3	Malleable Iron Threaded Fittings Class 150 and 300
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B16.9	Factory-Made Wrought Steel Buttwelding Fittings
ANSI B16.11	Forged Steel Fittings, Socket Welding and Threaded
ANSI B16.12	Cast Iron Threaded Drainage Fittings
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
ASTM A53	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless

Reference	Title
ASTM A105/A105M	Forgings, Carbon Steel, for Piping Components
ASTM A106	Seamless Carbon Steel Pipe for High–Temperature Service
ASTM A126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A197	Cupola Malleable Iron
ASTM A234/A234M	Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A536	Ductile Iron Castings
ASTM C564	Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D2241	Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR–PR)
ASTM D2665	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
AWWA C105	Polyethylene Encasement for Ductile–Iron Piping for Water and Other Liquids
AWWA C110	Ductile–Iron and Gray–Iron Fittings, 3 Inch Through 48 Inch, for Water and Other Liquids
AWWA C111	Rubber–Gasket Joints for Ductile–Iron and Gray–Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile–Iron and Gray–Iron Pipe with Threaded Flanges
AWWA C151	Ductile–Iron Pipe, Centrifugally Cast in Metal Molds or Sand–Lined Molds, for Water or Other Liquids
AWWA C200	Steel Water Pipe 6 Inches and Larger
AWWA C205	Cement–Mortar Protective Lining and Coating for Steel Water Pipe—4 In. and Larger—Shop Applied
AWWA C206	Field Welding of Steel Water Pipe

Reference	Title
AWWA C207	Steel Pipe Flanges for Waterworks Services—Sizes 4 In. through 144 In.
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold–Applied Tape Coating for Special Sections, Connections, and Fittings for Steel Water Pipelines
AWWA C210	Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipe
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C600	Installation of Ductile–Iron Water Mains and Their Appurtenances
AWWA C651	Disinfecting Water Mains
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water
AWWA M11	Steel Pipe—A Guide for Design and Installation
FEDSPEC L–C–530B(1)	Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy
MIL–H–13528B	Hydrochloric Acid, Inhibited, Rust Removing
MIL–STD–810C	Environmental Test Methods
UPC	Uniform Plumbing Code

B. Fittings and Coupling Compatibility – To assure uniformity and compatibility of piping components, fittings and couplings for grooved–end or shouldered–end piping systems shall be furnished by the same manufacturers.

C. Piping Supports, Seismic Restraints, and Expansion Control – Piping supports, seismic restraints, anchorage, and expansion control shall be designed by the Contractor's Design Professional selected under paragraph 40 27 05–1.01A. There may be situations where the Owner wants to control where certain anchors are located, the level of forces that can be transmitted to structures, the direction that expansion growth is allowed, or requires use of particular piping elements. In such cases these elements will be shown and shall be incorporated into the Design Professional's design.

Mandatory anchorage locations will be identified on the mechanical drawings, and maximum limitations, if any, for structure loads from the anchor will listed in kips, e.g. "X, 50", identifying location and 50,000 lb–force. Where structural load would be exceeded, piping flexibility or expansion joints shall be provided to achieve the maximum loading. If a support, anchor, seismic restraint or expansion element is detailed on the drawings, then those elements shall be incorporated into the

Contractor's design. Piping submittals by the Contractor shall include all elements, including those portions directed by the Owner, as well as complete piping runs. The structural reaction loads for all fixed supports shall be calculated and shown. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

D. Buried Piping – All buried piping shall be designed as fully–restrained systems. Where required, Design Professional shall size temporary and/or permanent thrust restraints. Restraint systems shall be designated to allow complete piping system disassembly without destructive measures.

Buried piping shall be provided as specified. Unless otherwise noted, materials specified in the PIPESPEC shall be used. Thicknesses specified in the PIPESPEC or referenced specifications shall be considered minimums. Excavation, installation and backfill shall be as specified.

Piping submittals by the Contractor shall include all elements, including those portions directed by the Owner, as well as complete piping runs. If a particular type of restraint or expansion element or approach is detailed on the drawings, then those elements shall be incorporated into the Contractor's design. The Contractor's Design Professional shall, as part of the submittal process, notify the Owner if he believes any Owner–shown elements are incompatible with the overall piping system and its function.

Additional requirements are specified in related sections.

1.03 SUBMITTALS

The following material shall be submitted for approval:

1. The qualifications of the Design Professional to be charged with design, inspection and certification of pipe supports, thrust and seismic restraints and pipe expansion control systems including education, proof of registration, proof of insurance, and previous experience in performing this type of work. The documentation shall be sufficient to demonstrate compliance with the requirements of paragraph 40 27 05–1.01 A. ***No further submittals under this or any related section will be considered until the qualifications of the Design Professional have been reviewed and accepted by the Construction Manager of Engineer of Record.***

2. A copy of this specification section, along with Sections 40 05 15, 40 05 15.10 and 40 05 15.15, 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 and Engineer of Record 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.**

PART 2 – PRODUCTS

2.01 PIPING MATERIALS

Unless otherwise specified, piping materials, including pipe, gaskets, fittings, connection and joint assemblies, linings and coatings, shall be selected from those listed on the piping system specification sheets. Piping materials shall conform to detailed specifications for each type of pipe and piping appurtenance specified in other sections of Division 40.

New and existing piping is designated by service rather than pipe material. Existing pipe material types may not be the same as material types specified for new piping. Contractor shall investigate and provide suitable connections, including electrical isolation, as necessary.

2.02 PIPING IDENTIFICATION

A. Plastic Coding Markers – Plastic markers for coding pipe shall conform to ANSI A13.1 and shall be as manufactured by W. H. Brady Company, Seton Name Plate Corporation, Marking Services Inc., or equal. Markers shall be the mechanically attached types that are easily removable; they shall not be the adhesive applied type. Markers shall consist of pressure sensitive legends applied to plastic backing which is strapped or otherwise mechanically attached to the pipe. Legend and backing shall be resistant to petroleum based oils and grease and shall meet criteria for humidity, solar radiation, rain, salt, fog and leakage fungus, as specified by MIL–STD–810C. Markers shall withstand a continuous operating temperature range of –40 degrees F to 180 degrees F. Plastic coding markers shall not be the individual letter type but shall be manufactured and applied in one continuous length of plastic.

Markers bearing the legends on the background colors specified in the PIPESPEC shall be provided in the following letter heights:

Outside Pipe Diameter,[a] Inches	Letter height, inches
Less than 1–1/2	1/2
1–1/2 through 3	1–1/8
Greater than 3	2–1/4

[a] Outside pipe diameter shall include insulation and jacketing.

In addition, pipe markers shall include uni– and bi–directional arrows, indicating flow direction, in the same sizes as the legend. Legends and arrows shall be white on blue or red backgrounds and black on other specified backgrounds.

B. Plastic Tracer Tape – Tracer tape shall be 6 inches wide, colored the same as the background colors as specified in Table A, paragraph 40 27 05–3.07, and made of inert plastic material suitable for direct burial. Tape shall be capable of stretching to twice its original length and shall be as manufactured by Allen Systems, W. H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal.

Two messages shall be printed on the tape. The first message shall read ***"CAUTION CAUTION CAUTION ________ PIPE BURIED BELOW"*** with bold letters approximately two inches high. The blank shall be filled with the particular system fluid such as chlorine, oxygen or sulfur dioxide. The second message shall read "***CALL***__________" with letters approximately 3/4 inch high. Both messages shall be printed at maximum intervals of 2 feet.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be as manufactured by Allen Systems, W.H. Brady Co., Seton Name Plate Corporation, Marking Services Inc., or equal. Tape shall be acid and alkali–resistant, three inches wide, 0.005-inch thick, and have 1,500 psi strength and 140% elongation value. The tape shall be colored the same as the background colors as specified in paragraph 40 27 05–3.07 and shall be inscribed with the words **"CAUTION—PIPE BURIED BELOW"** and the name of the piping system.

2.03 VALVES

Valves of the same size and service shall be provided by a single valve manufacturer. Packing shall be non–asbestos material. Actual length of valves shall be within 1/16 inch (plus or minus) of the manufacturer's specified length. Flanges shall meet the requirement of ANSI B16.5. Push–on and mechanical joints shall meet the requirements of AWWA C111. Valve operators are specified in Section 40 29 01.

2.04 PRODUCT DATA

Product data on piping materials and layout shall be submitted for approval:

A. Pre–Construction Data – All information specified shall be transmitted to the Engineer a minimum of four weeks prior to construction.

1. Design drawings and calculations for pipe supports, anchorage, seismic restraints, and expansion control systems as specified in Sections 40 05 15, 40 05 15.10, and 40 05 15.15. The drawings and calculations shall be sealed and submitted by the design professional specified in paragraph 40 27 05–1.02C through the Contractor. The Design Professional shall affirm that loads on structures are within the load limits noted on the contract documents.

2. Manufacturers' product literature on each bend, coupling, fitting, bolt, gasket, restraint or other item provided pursuant to this section.

3. A schedule showing the quantity provided and the piping system for each

item provided under this section.

4. Piping layout drawings, for both exposed and buried piping systems, depicting supports, locations of support, fittings and restraints, seismic restraint provisions, and other pertinent information, including wall and floor penetrations, where applicable. Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor and depicted on piping layout drawings. Drawings shall be original layouts by the Contractor; photocopies of contract drawings are not acceptable.

   Layout drawings and other Product Data shall be defined and depicted by system.

B. Post–Construction Data: - Inspection reports, authored, sealed and signed by the Design Professional retained under the provisions of paragraph 40 27 05–1.02 A. shall be submitted to the Construction Manager each week, as provided under paragraph 40 27 05–3.04. The Design Professional's final report shall be submitted to the Construction Manager and Engineer of Record before beneficial occupancy by the Owner, as provided under paragraph 40 27 05–3.04.

2.05 PIPE AND VALVE COMPATIBILITY

Selected pipe and pipe end connections for valves, or other equipment, shall be fully compatible within each piping system. Contractor shall coordinate the selection of pipe materials, linings and end connections so that valves operate properly over their entire range (e.g. sufficient disk clearance for butterfly valves). Selected end connections shall also be suitable for specified valve or equipment (e.g. wafer style valves or spectacle flanges shall be properly supported between flanges of equal inside diameter).

PART 3 – EXECUTION

3.01 INSTALLATION

A. Location – The Contract drawings are, in part, diagrammatic. Piping shall be provided as specified except for adjustments to avoid architectural and structural features and shall be coordinated with electrical construction. Adjustments to new piping shall be made to avoid interference and shown on the pipe layout drawings.

   Submitted piping layout drawings shall clarify detailed connections to new and existing equipment, piping and structures. Unless otherwise indicated on drawings, piping fitting angles and vertical and horizontal pipe locations shall be determined by Contractor.

B. Piping Sizes – Where the size of piping is not specified, the Contractor shall provide piping of the sizes required by UPC. Unless specified otherwise, small piping (less than one inch in diameter) required for services not described by UPC shall be 1/2 inch.

C. Existing Piping Materials – Contractor shall pothole existing pipe at connections to new pipe to confirm material and joints prior to commencement of work.

D. Pipe Support, Anchorage, and Seismic Bracing:

1. General – Piping shall be supported by anchor brackets, guides, saddles or hangers. Pipe movement due to thermal expansion and internal pressure and dynamic forces shall be accommodated by pipe springing, anchors, expansion joints, and guides selected for the specific purpose by the design professional retained under the provisions of paragraph 40 27 05–1.01 A. The details for the piping support, anchorage, seismic bracing, and expansion control systems shall be submitted with the Contractor's piping layout drawings as product data under the provisions of paragraph 40 27 05–2.04.

   Acceptable types of supports, guides, saddles, expansion joints, flexible couplings, hangers and structure attachments for general piping support, expansion/contraction and for seismic bracing, as well as anchorage details, are referenced in Sections 40 05 15, 40 05 15.10 and 40 05 15.15 or shown on the drawings. Where a specific type of support or anchorage is indicated on the drawings, then only that type shall be used at that location.

   Piping shall be vertically supported by anchor brackets, guides, saddles or hangers and shall be seismically braced as required to resist seismic loads. Supports shall be provided on each run at each change of direction. Piping supports manufactured of iron or steel shall be hot–dip or mechanically galvanized.

   Unless otherwise specified, existing pipes and supports shall not be used to support new piping. Existing tunnel pipe support racks can be used for new pipe if the Design Professional determines that the existing rack components are adequate to support the additional load.

2. Piping Connections to Machines – Piping at machine connections shall be aligned in all planes to permit insertion of bolts at bolted connections or coupling screwed connections without using jacks, come–a–longs or other mechanical means to align field piping with the connections at the machines. Bolts shall not be forced into mating flange bolt holes and shall be capable being withdrawn using finger pressure alone. The use of 'dutchmen' mitered sections or similar specials to achieve the required alignment with machine connections is strictly prohibited.

E. Anchorage for Buried Piping – All plugs, caps, tees and bends in buried pressure piping systems shall be anchored by means of reaction backing or restrained joints as specified.

F. Bedding and Backfill – Bedding and backfill for buried piping shall be as specified and as shown on the drawings.

G. Equipment Connection Fittings - Equipment connection fittings, as specified in Section 40 27 05.04, shall be provided between field piping systems and equipment inlet and outlet connections.

H. Buried Pipe at Structures – Unless otherwise specified, buried piping shall have two flexible fittings or couplings where pipe passes through structures per Section 40 27 05.04 and as shown on the drawings. Restraints across each joint shall be provided.

3.02 PIPING IDENTIFICATION

A. Pipe Coding – After application of the specified coating and insulation systems, exposed piping, interior and exterior, and piping in ceiling spaces, pipe trenches, pipe chases and valve boxes shall be identified with plastic markers as specified in paragraph 40 27 05–2.02 A. Legend markers and directional arrows shall be located at each side of walls, floors, and ceilings, at one side of each piece of equipment, at piping intersections, and at approximately 50-foot centers.

B. Plastic Tracer Tape – A single line of tape as specified in paragraph 40 27 05–2.02 B shall be provided 2.5 feet above the centerline of buried systems 4, 5, and 7 pipe. For systems 4, 5, and 7, pipelines buried eight feet or greater below finished grade, Contractor shall provide a second line of tape 12 inches below finished grade, above and parallel to each buried pipe. Tape shall be spread flat with message side up before backfilling.

C. Magnetic Tracer Tape – Polyethylene magnetic tracer tape shall be buried 12 to 18 inches below ground and shall be above and parallel to buried nonferrous, plastic and reinforced thermosetting resin pipe lines. For pipelines buried eight feet or greater below final grade, the Contractor shall provide a second line of tape 2.5 feet above and parallel to the buried pipe.

3.03 VALVE IDENTIFICATION

Stainless steel tags bearing the specified valve number stamped in 1/4–inch high letters shall be installed on valve flanges in a position visible from floor level. Flangeless valves eight inches in diameter and larger shall have tags attached to the valve body by self–tapping corrosion resistant metal screws. Flangeless valves six inches in diameter and smaller shall have tags attached to the valve stem by stainless steel wire. Wire shall be 0.063 inch minimum.

3.04 INSPECTION

The Contractor shall cause the Design Professional retained under the provisions of paragraph 40 27 05–1.01 A to inspect the interior installation of the piping supports, anchorage, seismic restraints, and expansion control systems provided under this contract.

Upon completion of construction, but prior to beneficial occupancy of the piping systems by the Owner, the Design Professional shall conduct a detailed final inspection and furnish the Construction Manager with a final report in accordance with Section 40 05 15 requirements.

3.05 TESTING

A. General – Upon completion of piping, but prior to application of insulation on exposed piping, the Contractor shall test the piping systems. Pressures, media and test durations shall be as specified in the PIPESPEC. Equipment which may be damaged by the specified test conditions shall be isolated. 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. Unless otherwise specified, the Contractor shall notify the Construction Manager 24 hours prior to each test.

Unless otherwise specified, testing, as specified herein, shall include existing piping systems which connect with new pipe systems. Existing pipe shall be tested to the nearest existing valve. Any piping which fails the test shall be repaired. Repair of existing piping will be considered and paid for as extra work.

B. Gas, Air, and Vapor Systems: The Contractor shall test steam lines hydrostatically in accordance with the ASME procedure for testing pressure piping.

Testing medium and procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D.

Unless otherwise specified, the testing medium for other gas, air and vapor systems shall be as follows:

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 than 2 inch	3 psi or less	Air or water
Greater than 2 inch	Greater than 3 psi	Water

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.

The allowable leakage rate for other systems tested with air shall be based on a maximum pressure drop of five 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.

C. Liquid Systems – Leakage shall be zero at the specified test pressure throughout the specified duration for the following systems: exposed piping, buried insulated piping, and buried or exposed piping carrying liquid chemicals. Testing procedures for chlorine and sulfur dioxide systems are specified in paragraph 40 27 05–3.05 D. Testing procedures for hydraulic and lube oil systems are specified in paragraph 40 27 05–3.05 E. Unless otherwise specified, 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.

D. Hydraulic and Fluid Power Oil Systems – Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Drains – Drain systems, other than pumped drain systems, shall be tested in accordance with UPC.

3.06 CLEANING AND FLUSHING

A. General – Piping systems shall be cleaned following completion of testing and prior to connection to operating, control, and 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 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 24 inches in diameter may be cleaned manually or with a cleaning ball or swab.

B. Temporary Screens – Upon completion of the cleaning, the Contractor shall connect the piping systems to related process equipment. Temporary screens, provided with locator tabs which 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 –1	1/16
1-1/4 – 3	1/4
3-1/2 – 6	1/2
Over 6	1

The Contractor shall maintain the screens during testing, initial start–up, and initial operating phases of the commissioning process. In special cases, screens may be removed as required for performance tests. The Contractor shall remove the temporary screens and make the final piping connections after the screens have remained clean for at least 24 consecutive hours of operation. Liquid systems handling solids shall have screens in place for clear water testing and operation. Initial operation on solids following clear water testing may be without screens.

C. Gas and Air Systems – Unless otherwise specified, gas and air system piping six inches in diameter and smaller shall be blown out, using air or the testing medium specified. Piping larger than six 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 airstream. Sludge gas, natural gas and propane systems shall be purged with nitrogen and a nitrogen pad maintained at 10 psi until put in service. Chlorine and sulfur dioxide systems shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

D. Liquid Systems – 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 15 minutes and until no debris is collected on the screens. Liquid chlorine and sulfur dioxide lines shall be cleaned in accordance with paragraph 40 27 05–3.06 E.

Upon completion of all field piping, but before connection to any control components, hydraulic and fluid power oil systems shall be flushed and cleaned by circulating special flushing oil through the system. Flushing oil and procedures shall comply with ASTM D4174. System shall be cleaned such that internal contamination of system, when tested using procedures specified in SAE J1227, Section 2.3, shall not exceed the Allowable Cleanliness Level (ACL). Unless otherwise specified, the ACL value shall be established by the manufacturer of the major hydraulic system components in accordance with SAE J1227, Section 9.1. System supplier shall provide Certificate of Compliance as product data (paragraph 40 27 05–2.04) that the ACL has been met.

E. Potable Water Systems – Potable water piping systems shall be flushed and disinfected in accordance with AWWA C651.

3.07 PIPING SPECIFICATION SHEETS (PIPESPEC)

Piping and valves for groupings of similar plant processes or types of service lines are specified on individual piping specification sheets (PIPESPECS). Piping services are grouped according to the chemical and physical properties of the fluid conveyed and/or by the temperature or pressure requirements. Each grouping of services (PIPESPEC) is identified by a piping system number. Piping services specified in the PIPESPECS and on the drawings are alphabetically arranged by designated service symbols as shown in Table A. Table A also indicates the piping material system number, fluid category, and pipe marker background color of each service.

Table A: Process Piping Services

Pipe Designation	Pipe Service	Material	Interior Lining	Test Pressure, Psi
2W	Nonpotable City Water	ST	–	200
3W	Service Water (Filtered Effluent)	ST	–	200
CA	Compressed Air	SS	–	20
DR / TD	Drain	DI	CL	125
DSF	Diesel Fuel	ST	–	150
FE	Final Effluent	DI	CL	125
NaOH	Sodium Hydroxide	PVC	–	150
PA	Process Air	SS	–	20
PRMT (inside)	Permeate	PVC	–	125
RAS	Return Activated Sludge	ST /DI	EP	125
RS	Raw Sewage	ST /DI	EP	125
SHC	Sodium Hypochlorite	PVC*	–	150
SL	Sludge	DI	EP	100
WAS	Waste Activated Sludge	ST /DI	EP	125

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service CA—Compressed Air
PA – Process Air

Test Requirements:

Medium: Air; ref. spec paragraph 40 27 05–3.04 B.
Pressure: 20 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Mech Cpl: EPDM

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Stainless steel; ASTM A312, Schedule 40S. Ref. spec Section 40 27 01.05.
Conn; threaded, ANSI B1.20.1.
Ftgs; ASTM A403, material, ends and wall thickness to match pipe.

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Lift check; Crane 27TFE, Lunkenheimer 231, or equal.

(3" and larger)

Pipe: Stainless steel; ASTM A778. Ref. spec Section 40 27 01.05.
Conn; butt weld or flanged, couplings where specified.
Ftgs; ASTM A774, material, ends and wall thickness to match pipe.

Valves: Butterfly; ref. spec. Section 40 29 13. Line with 10 mils of epoxy per spec Section 40 27 01.02.

Remarks:

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: FE—Final Effluent

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig

Duration: 60 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder

Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:

(See drawings for pipe size and valve type)

(3" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.

Conn; taper threaded, ANSI B1.20.1. Flanged adapters for 2–1/2 inch, 3 inch valves.

Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

(2" and smaller)

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.

Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.

Swing check; Crane 137, Lunkenheimer 230, or equal.

(4" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, with cement mortar lining. Ref. spec Section 40 27 01.02.

Conn; grooved mech pipe coupling or flanged.

Ftgs; malleable iron, ductile iron, or steel, per spec Section 40 27 01.02; ends and lining to match pipe.

Or

Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.

Conn; Flanged.

Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

(2 1/2" thru 8")

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.

Swing check; spring loaded per spec Section 40 29 27.

(10" thru 24")

Pipe: Steel; same as 8 inch or AWWA C200, 3/16 inch thick, with cement mortar lining. Ref. spec Section 40 27 01.02.

Conn; same as 8 inch. See Remarks.

Ftgs; steel, ASTM A234, or fabricated steel, AWWA C208. Lining and ends to match pipe.

Valves: Butterfly; ref. spec Section 40 29 13.
Check; per spec Section 40 29 27.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, NSF certified, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.

(4" to 12")

Pipe: Ductile iron; AWWA C151 with cement mortar lining. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push–on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: 2W—No. 2 Water (nonpotable City Water)
3W—No. 3 Water (Filtered / Chlorinated Effluent)

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 200 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A53, galvanized. Ref. spec Section 40 27 01.02.
Conn; taper threaded, ANSI B1.20.1.

Ftgs; malleable iron, ASTM A197, ANSI B16.3, Class 150, galvanized.

Valves: Ball; Jamesbury Fig. 351, Nibco T–580, or equal.
Globe; Crane 7TF or 17TF, Lunkenheimer 123 or 214, or equal.
Swing check; Crane 137, Lunkenheimer 230, or equal.

(2 1/2" thru 8")

Pipe: Steel; ASTM A53, ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Butterfly; Ref. spec Section 40 29 13. Substitute Type B on 2–1/2–inch lines.
Check; per spec Section 40 29 27.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

Valves: Gate; ref. spec Section 15101, with extension stem and valve box. Coating.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; grooved end or restrained push–on rubber gasket joint. Flanged adapters for valves.
Ftgs; ductile iron per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Butterfly; same as exposed with extension stem and valve box. Coating.

Remarks:

1. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08–3.03.

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: TD–Tank Drain

Test Requirements:

	Medium:	Water; ref. spec paragraph 40 27 05–3.04 C.
	Pressure:	125 psig
	Duration:	120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder

Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2 1/2" thru 4")

Pipe: Steel; ASTM A53 ERW, Grade B, black, no lining. Ref. spec Section 40 27 01.02.
Conn; butt weld, grooved mech pipe coupling or flanged.
Ftgs; malleable iron, ductile iron, or steel per spec Section 40 27 01.02; ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

(6" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

Valves: Mud Valves; per spec Section 40 29 50.

Buried and Encased Pipe:
(See drawings for pipe size. Omit coating on encased pipe.)

(3" and smaller)

Pipe: PVC; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Ref. spec Section 15064. Provide magnetic tracer tape.
Conn; plain end; solvent weld with threaded or flanged adapters for valves.
Ftgs; PVC, Sch. 80, socket weld.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; Flanged.

Ftgs; ductile iron, per spec Section 33 05 01.03; coating, lining and ends to match pipe.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: RAS—Return Activated Sludge
WAS—Waste Activated Sludge
RS– Raw Sewage Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 125 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(3" and smaller)

Pipe: Steel; ASTM A53, galvanized. .
Conn; taper threaded, ANSI B1.20.1.
Ftgs; malleable iron, ASTM A197, ANSIB16.3, Class 150, galvanized.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Swing check; Lunkenheimer 230, Crane 137, or equal.

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Epoxy Lined Ref. spec Section 33 05 01.03.
Conn; flanged.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 19. Install valve with seat upstream.
Check; per spec Section 40 29 27.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: SL—Sludge

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 100 psig
Duration: 120 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–on/Mech Cpl: Nitrile or Neoprene

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(4" thru 12")

Pipe: Ductile iron; AWWA C151. Ref. spec Section 33 05 01.03.
Conn; flanged or mechanical.
Ftgs; ductile iron, per spec Section 33 05 01.03; ends to match pipe.

Valves: Eccentric plug; per spec Section 40 29 019. Install valve with seat upstream.

PIPING SPECIFICATION SHEETS —PIPESPEC

Piping Symbol/Service: DSF—Diesel Fuel

Test Requirements:

Medium:	Fuel oil; ref. spec paragraph 40 27 05–3.04 E.
Pressure:	150 psig (pressure piping) 5 psig (nonpressure piping)
Duration:	60 minutes

Gasket Requirements:

Flange: Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder
Push–On/Mech Call: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(2" and smaller)

Pipe: Steel; ASTM A106, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.
Conn; threaded or socket weld with threaded adapters for valves.
Ftgs; forged steel, ASTM A105, ANSI B16.11, pressure Class 3000, pickled.

Valves: Lubricated plug; cast iron, PTFE coated plug, Nordstrom Fig. 142, Walworth Fig. 1796, or equal.
Lift check; Crane 27TF, Lunkenheimer 231, or equal.

(2 1/2" thru 12")

Pipe: Steel; ASTM A53, seamless, Grade B, black, pickled. Ref. spec Section 40 27 01.02.

Conn; butt weld, flanged for valves.
Ftgs; steel, ASTM A234, seamless, ANSI B16.9, pickled; ends shall match pipe.

Valves: Lubricated plug; cast iron with PTFE or molydisulfide coated plug, Nordstrom Fig. 143, Walworth Fig. 1797F, or equal, thru 5 inch; worm gear operator Rockwell Fig. 149, Walworth Fig. 1727F, or equal, 6 to 12 inches.

Swing check; cast iron, flanged, Jenkins 1025–B2, Walworth 5344F, or equal.

Buried and Encased Pipe and Valves:
(See drawings for pipe size and valve type.)

(2" and larger)

Pipe: Reinforced thermosetting resin (RTRP); Type 1, ref. spec Section 15058. Double containment unless otherwise specified. Provide magnetic tracer tape.
Conn; bonded bell and spigot or flanged.
Ftgs; RTRP to match pipe, ref. spec Section 15058.

Valves: Lubricated plug; same as exposed with extension stem and valve box.

Remarks:

1. The cleaning (pickling) solution used shall comply with Mil–H–13528B. Immediately following pickling and rinsing procedures, steel pipe and fittings shall be coated inside and outside with a rust and corrosion preventative system, and the ends sealed to prevent the entry of dirt.

PIPING SPECIFICATION SHEETS –PIPESPEC

Piping Symbol/Service: PRMT – Permeate
NaOH–Caustic Soda
SHC—Sodium Hypochlorite (See Remark 1)

Test Requirements:

Medium: Water; ref. spec paragraph 40 27 05–3.04 C.
Pressure: 150 psig
Duration: 120 minutes

Gasket Requirements:

Flange: PTFE bonded EPDM, full–face gaskets, ANSI B16.1.
Push–on/Mech Cpl: N/A

Exposed Pipe and Valves:
(See drawings for pipe size and valve type)

(All sizes)

Pipe: <u>PVC</u>; ASTM D1784, Class 12454–B, ASTM D1785, Sch. 80. Pipe and fittings exposed to sunlight shall be painted. Ref. spec Section 15064.
<u>Conn</u>; plain end, solvent weld, flanged for valves 3 inch and larger.
<u>Ftgs</u>; PVC, Sch. 80, solvent weld.

(4" and less)

Valves: <u>Ball</u>; PVC Chemtrol Tru Bloc TU Series, Asahi/America Duo Bloc TU Series, GSR TU Series, or equal, with PTFE seats and EPDM 0–rings.
<u>Diaphragm</u>; PVC body, Chemtrol Series PD, Posacon 677, Asahi/America, or equal with EPDM or PTFE diaphragm.
<u>Ball check</u>; PVC body, Chemtrol Series BC, Asahi/America, or equal with EPDM or PTFE seats/seals.

(5" and larger)

Valves: <u>Diaphragm</u>; ITT Dia–Flo 2558–2–M, Hills–McCanna 0649–1–38, or equal.
<u>Swing or ball check</u>; fully lined valve body; fully coated swing check flapper or ball check ball; lining and coating shall be Hypalon or fluorinated ethylene propylene. Valve and Primer Co. APCO Series 100R, Peabody Dore Model 770, or equal.

<u>Buried and Encased Pipe and Valves</u>:
(See drawings for pipe size and valve type)

(All sizes)

Pipe: <u>PVC</u>; same as exposed. Provide magnetic tracer tape.
<u>Conn</u>; same as exposed.
<u>Ftgs</u>; same as exposed.

(2" and less)

Valves: <u>Ball</u>; same as exposed with extension stem and valve box.

(2 1/2" and larger)

Valves: <u>Diaphragm</u>; same as exposed with extension stem and valve box.

<u>Remarks</u>:

1. For HOCL service, the following shall apply:

a. Ball valves are not permitted on HOCL service.

b. Diaphragm valves 4 inches and smaller shall be provided with PTFE diaphragms; valves 5 inches and larger shall be provided with Hypalon or PDVF linings with PTFE diaphragms.

c. Sodium hypochlorite solvent weld shall be with adhesives developed specifically for NaOCL service.

2. Manual air vents shall be provided at the high points and drains provided at the low points of each reach of pipeline as specified in paragraph 40 27 05.08–3.03.

END OF SECTION

INDEX TO

SECTION 40 27 05.02 – JOINT GASKETS

SECTION 40 27 05.02

JOINT GASKETS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies rubber gaskets for push-on compression type joints used with fabricated steel pipe, steel pipe, reinforced concrete pipe, concrete cylinder pipe, and cement mortar lined and coated steel pipe.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM D395	Rubber Property--Compression Set, Test for
ASTM D412	Rubber Properties in Tension, Test for
ASTM D471	Rubber Property--Effect of Liquids, Test for
ASTM D573	Rubber--Deterioration in an Air Oven, Test for
ASTM D1149	Rubber Deterioration--Surface Ozone Cracking in a Chamber (Flat Specimens), Test for
ASTM D2240	Rubber Property--Durometer Hardness, Test for

B. Testing - Certified copies of test reports indicating that the gasket material has been tested and that the results of the tests comply with the requirements specified in paragraph 40 27 05.02-2.02 shall be provided as product data.

PART 2 – PRODUCTS

2.01 MATERIALS

Gasket stock shall be a synthetic rubber compound in which the elastomer is neoprene. The compound shall contain no less than 50% by volume neoprene and shall be free from factice, reclaimed rubber and other deleterious substances.

2.02 PHYSICAL REQUIREMENTS

The compound shall meet the following physical requirements when tested in accordance with the specified ASTM standards.

A. Tensile (ASTM D412) – The tensile strength shall be 1,500 psi minimum and the ultimate elongation shall be 350 percent minimum.

B. Hardness (ASTM D2240, Type A Durometer) – The compound shall have a hardness in the range of 35 to 50 for concrete spigots and 50 to 65 for steel spigots.

C. Compression Set (ASTM D395) – The compression set shall not exceed 20% when compressed for 22 hours at 70 degrees C.

   The test specimens shall be circular discs cut from the gaskets. Test specimens shall be 0.500 ($\pm$ 0.005 - 0.025) inches in height. The diameter of the test specimen shall be that of the gasket but not to exceed 1.129 $\pm$ 0.010 inches in diameter.

D. Aging (ASTM D573) – The test specimen deterioration shall be less than 20 percent reduction in tensile strength, 40 percent reduction in ultimate elongation, and 15 points increase in hardness.

E. Effect of Liquids (ASTM D471): The maximum volume change in oil and in water shall be as follows:

   1. Oil: 100% in ASTM oil No. 3.

   2. Water: 15%.

   The test specimens shall have a thickness of 0.080 $\pm$0.005 inches and shall be circular discs cut from the gasket.

F. Ozone Cracking (ASTM D1149) – The test specimen shall be a gasket loop mounted to give at least 20% elongation. There shall be no cracking visible at two times magnification of the gasket after 100 hours exposure to 1 mg/l ozone at 40 °C.

2.03 PRODUCT DATA

Provide certified copies of test reports specified in paragraph 40 27 05.02-1.02 B.

PART 3 – EXECUTION

The gaskets shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 27 05.04 – PIPING CONNECTIONS

SECTION 40 27 05.04

PIPING CONNECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

This section specifies the following methods of connecting metallic piping: flanges, threading, mechanical couplings, equipment connection fittings, dielectric unions, and welding.

1.02 REFERENCES

This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME BI.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI BI.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI B18.2.1	Square and Hex Bolts and Screws Inch Series
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI B31.1	Power Piping
ANSI B31.3	Chemical Plant and Petroleum Refinery Piping
ASME Section IX	Boiler and Pressure Vessel Code; Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Qualifications
ASTM B98	Copper-Silicon Alloy Rod, Bar and Shapes
ASTM F37	Standard Test Methods for Sealability of Gasket Materials
ASTM F104	Standard Classification System for Nonmetallic Gasket Materials

Reference	Title
ASTM F152	Standard Test Methods for Tension Testing of Nonmetallic Gasket Materials
ASTM F593	Stainless Steel Bolts, Hex Cap Screws, and Studs
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service-Size 4 in. through 144 in.
AWWA C219	Bolted, Sleeve-Type Couplings for Plain-End Pipe
AWWA C550	Protective Epoxy Coatings for Valves and Hydrants
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe-A Guide for Design and Installation
NSF 61	Drinking Water System Components - Health Effects

1.03 SUBMITTALS

Provide catalog data demonstrating compliance with this specification and giving full description of the piping connections shall be provided in accordance with contract submittal requirements.

PART 2 – PRODUCTS

2.01 FLANGE ASSEMBLIES

A. Flanges:

1. General – Flanges shall either be flat flanges or convoluted ring flanges as specified in the following paragraphs.

2. Flat Flanges – Cast iron flanges shall be faced in accordance with ANSI B16.1. Where companion flanges are used, the flanges on pipe shall be refaced to be flush with the companion flange face. Class 150 and Class 300 forged steel flanges shall be raised face conforming to ANSI B16.5. Lightweight slip-on flanges shall be plain face conforming to AWWA C207, Class B and ANSI B16.5. Unless otherwise specified, steel flanges shall be ANSI B16.5, Class 150 or AWWA C207, Class D. Class E AWWA flanges shall be provided where test pressure exceeds 175 psi. Plain faced flanges shall not be bolted to raised face flanges.

3. Convoluted Ring Flanges – Convoluted ring flanges shall be ductile iron, forged steel or cast stainless steel, designed to bear on hubs welded to the pipe and shall be as manufactured by Improved Piping Products. The Construction Manager knows of no equal. The flange joints shall be rated for not less than 150% of the test pressures listed in Section 40 27 05 and shall conform to the requirements of ANSI B 16.5 and AWWA C207. The flange manufacturer shall be prepared to demonstrate, by certified pressure test that the flanges will meet these requirements.

B. Gaskets:

1. Gasket material shall be as specified in paragraph 40 27 05.04-2.03.

2. Gaskets for plain faced flanges shall be the full-face type. Thickness shall be 1/16 inch for pipe 10 inches and less in diameter, and 1/8 inch for pipe 12 inches and larger in diameter. Unless otherwise specified, gaskets for raised face flanges shall match the raised face and shall be 1/16-inch-thick for pipe 3-1/2 inches and less in diameter and 1/8-inch-thick for pipe 4 inches and larger.

C. Bolts:

1. Flange assembly bolts shall be ANSI B18.2.1 standard square or hexagon head bolts with ANSI B18.2.2 standard hexagon nuts. Threads shall be ANSI Bl.1, standard coarse thread series; bolts shall be Class 2A, nuts shall be Class 2B. Bolt length shall conform to ANSI B16.5. **All bolts shall be coated with an anti-seized product. No bolt treads shall be painted.**

2. Unless otherwise specified, bolts shall be carbon steel machined bolts with hot pressed hexagon nuts. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

2.02 MECHANICAL COUPLINGS

A. Sleeve-Type Couplings:

1. Unless otherwise specified, sleeve-type mechanical pipe couplings shall be Smith-Blair Type 411, Dresser Style 38, or equal, with the stop removed from the middle ring. Reducing couplings shall be Smith-Blair Type 415, Dresser Style 62, or equal. Sleeve-type flanged coupling adapters shall be Smith-Blair Type 913, Dresser Style 128, or equal. Insulating couplings shall be Smith-Blair Type 416, Dresser Style 39, or equal.

2. Bolts for submerged service shall be made of Type 316 stainless steel in conformance with ASTM F593, markingF593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04, or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C111.

B. Plain End Couplings:

1. Plain end pipe couplings for pipe sizes 6 inches and smaller shall be Gustin-Bacon 200, Victaulic Style 99, or equal for Schedule 80 pipe and Gustin-Bacon 205, Victaulic Style 90, or equal for lighter weight pipe. Plain end couplings for pipe sizes 8 inches and larger shall be Gustin-Bacon 200, Victaulic Style 99, or equal. Unless otherwise specified, bolts and nuts shall comply with AWWA C606.

2. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C606.

C. Grooved End Couplings:

1. Grooved end flexible-type couplings shall be Gustin-Bacon 100, Victaulic Style 77, or equal. Grooved end rigid-type couplings shall be Gustin-Bacon 120 Rigi-Grip, Victaulic Style 07 Zero-Flex, or equal. Flexible-type couplings shall be used for all piping greater than 12 inches in diameter; for pipe 12 inches in diameter and less in rack-mounted tunnel piping applications; and for grooved joints adjacent to pump or blower suction and discharge where grooved couplings are used for noise and vibration control. All other applications for piping 12 inches in diameter and less shall utilize rigid-type couplings. Grooved end flanged coupling adapters shall be either Gustin-Bacon 154, Victaulic Style 741, or equal. Snap-joint grooved end couplings shall be Gustin-Bacon 115, Victaulic Style 78, or equal. Cut grooves are not permitted on fabricated or lightwall pipe.

2. Unless otherwise specified, bolts and nuts shall comply with AWWA C606. Bolts for submerged service shall be Type 316 stainless steel in conformance with ASTM F593, marking F593F. Nuts for submerged service shall be made of copper-silicon alloy bronze conforming to ASTM B98, alloy C65100, designation H04 or alloy C65500, designation H04. Bolts and nuts for buried service shall be made of noncorrosive high-strength, low-alloy steel having the characteristics specified in ANSI/AWWA C111/A21, regardless of any other protective coating. Where washers are required, they shall be of the same material as the associated bolts.

3. Gaskets shall be as specified in paragraph 40 27 05.04-2.03 and AWWA C 606.

D. Dismantling Joints – Dismantling joints may be used as takedown couplings in accordance with paragraph 40 27 05.04-3.03. Dismantling joints shall fully restrained double flange fittings consisting of a flange coupling adapter and flanged spool piece that allows for longitudinal adjustment. Thrust restraint shall be provided by means of all threaded rod spanning between flanges and secured to the flanges with a minimum of two flange bolts. Design of equipment connection fittings shall conform to AWWA C219. Sleeves shall be carbon steel or as specified for the specific piping system. Pressure rating of flange adapters shall equal or exceed the pressure rating of mating flanges. All metal portions of equipment connection fittings, with the exception of 316 stainless steel components, shall be coated and lined with fusion bonded epoxy conforming to AWWA C550 and NSF 61. Dismantling joints shall be Romac DJ-400, Smith Blair 975, or Crane-Viking Johnson Dismantling Joint.

E. Sleeve Band Couplings – Sleeve band couplings shall be Victaulic Depend-O-Lock. Unless otherwise noted, couplings for liquid service shall be Model F x F Type 2 fully restrained, shouldered high deflection couplings with standard width band. Couplings shall comply with AWWA C-219. Couplings for use with air systems shall be Airmaster restrained Depend-O-Lock couplings in conformance with AWWA C-606. Sleeve band couplings are acceptable wherever sleeve type couplings are used (paragraph 40 27 05.04-2.02 A.)

2.03 GASKETS

Gaskets designated in Section 40 27 05 shall be as follows:

A. EPDM: ethylene-propylene-diene-terpolymer.

B. Neoprene: neoprene.

C. Nitrile: nitrile (Buna N).

D. Compressed gasketing consisting of organic fibers (Kevlar) and neoprene binder; ASTM F104 (F712400), 2500 psi (ASTM F152), 0.2 ML/HR LEAKAGE FUEL A (ASTM F37).

E. Compressed gasketing consisting of organic fibers (Kevlar) and SBR binder; ASTM F104 (F712400), 2500 PSI (ASTM F152), 0.1 ml/hr leakage Fuel A (ASTM F37).

F. Gylon gasketing, Garlock Style 3500, 2000 psi (ASTM F152), 0.22 ml/hr Fuel A (ASTM F37).

G. Gylon gasketing, Garlock Style 3510, 2000 psi (ASTM F152), 0.04 ml/hr Fuel A (ASTM F37).

H. Gylon gasketing, Garlock Style 3504, 2000 psi (ASTM F152), 0.12 ml/hr Fuel A (ASTM F37).

I. TFE: noncreeping tetrafluoroethylene (TFE) with insert filler.

J. PTFE bonded EPDM: PTFE bonded to EPDM in full-face gasket having concentric-convex molded rings; Garlock Stress Saver 370 or equal.

2.04 THREAD

Pipe thread dimensions and size limits shall conform to ANSI BI.20.1.

2.05 DIELECTRIC UNIONS

Dielectric unions shall be EPCO, Capitol Manufacturing, or equal.

2.06 COATINGS

Unless otherwise specified, flange assemblies and mechanical type couplings for buried installation shall be field coated.

2.07 PRODUCT DATA

The Contractor shall provide for each welder, a welder qualification certificate indicating the welder is certified for pipe welding in accordance with ASME Boiler and Pressure Vessel, Section IX. Each welder's certificate shall be provided to the Construction Manager prior to that welder working on the job.

PART 3 – EXECUTION

3.01 PIPE CUTTING, THREADING, AND JOINTING

Pipe cutting, threading, and jointing shall conform to the requirements of ANSI B31.1.

3.02 PIPE WELDING

A. Pipe shall be welded by ASME-certified welders using shielded metal arc, gas shielded arc or submerged arc welding methods. Welds shall be made in accordance with the requirements of ANSI B31.1 for piping Systems 8, 26, and 28 specified in Section 40 27 05. Welds shall be made in accordance with the requirements of ANSI B31.3 for piping System 20 specified in Section 40 27 05.

B. Welds for piping systems not specified above shall be made in accordance with AWWA C206.

3.03 TAKEDOWN COUPLINGS

A. Takedown couplings shall be screw unions, flanged or grooved end mechanical coupling type joints and shall be provided as specified. Flanged or grooved end joints shall be employed on pipelines 2-1/2 inches in diameter and larger. Where piping passes through walls, takedown couplings shall be provided within three feet of the wall, unless specified otherwise.

B. A union or flanged connection shall be provided within two feet of each threaded end valve.

3.04 FLEXIBILITY

Unless otherwise specified, piping passing from concrete to earth shall be provided with two pipe couplings or flexible joints (or a single Flexijoint) as specified on the buried pipe within two feet of the structure for 2-inch through 6-inch diameter pipe; within three feet of the structure for 8-inch through 24-inch diameter pipe; and within 1.5 pipe diameters of the structure for larger pipe. Where required for resistance to pressure, mechanical couplings shall be restrained in accordance with Chapter 13 of AWWA M11, including Tables 13-4, 13-5 and 13-5A, and Figure 13-20.

3.05 DIELECTRIC CONNECTIONS

Where a copper pipe is connected to steel or cast-iron pipe, an insulating section of rubber or plastic pipe shall be provided. The insulating section shall have a minimum length of 12 pipe diameters. Dielectric unions as specified in paragraph 40 27 05.04-2.05 may be used instead of the specified insulating sections. Where copper pipe is supported from hangers, it shall be insulated from the hangers, or copper-plated hangers shall be used.

END OF SECTION

INDEX TO

SECTION 40 27 05.06 – EXPANSION JOINTS

SECTION 40 27 05.06

EXPANSION JOINTS

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies piping expansion joints.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
EJMA STDS	Standards of Expansion Joint Manufacturers' Association, Edition No. 5

B. Selection Criteria – The selection and installation of expansion joints shall be in conformance with the expansion control system designed by the Design Professional, retained under the requirements of paragraph 40 27 05–1.01 A, and the criteria specified herein. This requirement, however, shall not be construed as relieving the Contractor of responsibility for this portion of the work.

C. Design Criteria:

1. General – Expansion joints shall be designed in accordance with EJMA Standards for pressure, temperature and service as specified in the Piping System Specification Sheets (PIPESPEC) without crimping of corrugations.

2. Expansion Joints – Corrugated type expansion joints shall be suitable for a minimum of 10,000 pressure, temperature and deflection cycles (non-concurrent).

1.03 SUBMITTALS

The following submittals shall be submitted for approval:

A. Design and construction details of formed metal bellows type expansion joints.

B. Pressure thrust force and spring rate data for formed metal bellows expansion joints.

C. Details for installation of all expansion joints.

D. A copy of this specification section with addenda updates, and all referenced sections with each paragraph check marked to show specification compliance or marked to show deviations.

PART 2 – PRODUCTS

2.01 EXPANSION JOINTS

A. Metal Construction:

1. Formed Bellows Type:

a. Formed bellows type expansion joints for temperatures up to 800 °F shall have 300 series stainless steel multi–ply bellows rated for the specified design temperature and pressure. Test pressures are specified in Section 40 27 05. Each expansion joint shall be factory tested at the test pressure. Ductwork expansion joints may be rated at less than 50 psig but must be rated equal to the design pressure and, in no case, less than 2 psig.

b. Expansion joint design shall be determined by the amount and kind of movement specified (axial, lateral, angular). Unless otherwise specified, end connections shall be flanged. Formed bellows type expansion joints shall be as manufactured by Flexonics, Inc., Hyspan Precision Products, Inc., American BOA Inc. or equal.

2. Steel Expansion Compensator Type – Steel expansion compensator type expansion joints shall be Flexonics Model H Expansion Compensator, Hyspan Series 8500, Keflex 7Q, or equal. Compensators shall have 2–ply stainless steel bellows and carbon steel shroud and end fittings. Compensators shall be rated for 175 psi maximum working pressure and 750 degrees F.

3. Bronze Expansion Compensator Type – Bronze expansion compensator type expansion joints shall be Flexonics Model HB Expansion Compensator,

Hyspan Series 8500, Keflex 7Q, American BOA Inc., or equal. Compensators shall have multi–ply phosphor bronze or stainless-steel bellows and copper tube end fittings. Compensators shall be rated for 150 psi maximum working pressure and 400 °F.

B. Elastomer and Fabric Construction:

1. General:

a. Elastomer and fabric expansion joints shall be the standard spool arch type or the precision molded spherical design type as indicated or specified. Expansion joint connectors shall have control units (restraints) to prevent excessive axial elongation and to accept the static pressure thrust in the piping system. Number and sizes of control rods or restraints shall be as determined by the manufacturer. Unless otherwise specified, single arch and sphere type expansion joints shall have 6–inch face–to–face dimension for pipe up to eight inches and 8–inch face–to–face dimension for pipe 10 and 12 inches.

b. The cover elastomer shall be chlorobutyl, neoprene or EPDM. For temperatures between 180 and 240 °F, the tube elastomer shall be chlorobutyl or EPDM. Neoprene or Buna N liners are acceptable for temperatures to 180 °F.

c. Elastomer and fabric type expansion joints used for exterior service shall have ultra–violet light protection.

d. Elastomer and fabric type expansion joints shall not be used for pump discharge piping and where surge forces may be expected.

2. Spool Type:

a. Spool type expansion joints shall be of the resilient arch type and shall be standard or tapered as specified. Unless otherwise specified, all tapered connectors shall be eccentric.

b. Spool type expansion joints shall be constructed of multiple plies of woven fabric impregnated with elastomer and reinforced with steel rings or wire embedded in the body. Standard arch type expansion joints suitable for the specified temperature and pressure shall be provided with retaining rings or backup rings. Retaining rings shall be 3/8–inch thick steel, split, either galvanized or zinc shield coated. Expansion joints, single, multiple, or filled arch, shall be Mason Style EJBN, Garlock Style 204, Mercer Style 500, Goodall Style E–1462, General Style 1025, or equal.

c. Filled arch type shall be used on all piping systems carrying fluids containing solids. High pressure couplings suitable for 240 °F operating temperatures shall be Mason Style EJBN–HD, Mercer Style 510, Garlock Style 204–HP, Goodall Style E–1489, General Style 1015, or equal.

3. Spherical Molded Type – Spherical molded type expansion joints shall be precision molded of multiple plys of nylon tire cord fabric and elastomer suitable for specified temperature and pressure. Spherical molded type expansion joints shall have steel or ductile iron floating flanges, and no metal parts shall come in contact with the fluid. Single sphere molded connectors shall be Mason Type MFNC, Mercer Type 5500, Goodall Type E–611, General Type 1010, Garlock Style 8100, or equal. Double sphere or triple sphere connectors shall be provided where required to provide for the specified movement.

C. Polyvinylchloride Construction - Polyvinylchloride expansion joints shall be Celanese "Chemtrol" CPVC slip type with Teflon impregnated seal rings, Certain–teed Fluid Tite PVC, Johns–Manville PVC double bell expansion joint, or equal.

D. Teflon Construction – Teflon expansion joints shall be molded TFE bellows and shall be Metraflex T–2, Garlock Style 215, Resistoflex R–6905, EGC Style M–150, or equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Expansion joints and anchors shall be located as specified. Location and number of guides shall be determined from EJMA Standards.

B. Expansion joints shall not be installed during times of temperature extreme or in a fully compressed or fully expanded condition.

C. Unless otherwise specified, expansion joints four inches and larger shall be furnished with control rods.

3.02 ALIGNMENT

Piping systems shall be aligned prior to installation of expansion joints. Expansion joints shall not be used to correct piping misalignment during installations. Expansion joints normally preset at the factory for rated axial compression and expansion shall be installed in this preset condition.

3.03 EXPANSION JOINT AND CONNECTOR SCHEDULE

Expansion joints provided for specific equipment items or piping systems are specified on the following schedule. The location of piping system expansion joints and design criteria, including temperature, pressure and movement for each joint, are specified and/or shown on the drawings.

Expansion Joint and Connector Schedule

Type of Expansion Joint/Connector	Type of Service/Use
Formed metal bellows; medium temperature (2.01 A.1.a.)	Boiler exhaust, hot water, high pressure air, and gas and steel lines subjected to ambient temperature differentials sufficient to require expansion joints.
Steel expansion compensator (2.01 A.2.)	Same type service/use as for "formed metal bellows type expansion joint" except size of piping is limited to 3-inch diameter or less.
Bronze expansion compensator (2.01 A.3.)	Copper piping.
Elastomer spool arch (2.01 B.2.)	Blower connectors and expansion joints for piping 14-inch diameter and larger.
Elastomer spherical molded (2.01 B.3.)	Blower connectors and expansion joints for piping 12-inch diameter and less.
PVC (2.01 C.)	PVC piping.
Teflon (2.01 D.)	RTRP (FRP) piping.
Teflon flexible connector (2.03)	Connection of PVC piping to chemical storage tanks.

[a] Excludes steam and chemical services.

END OF SECTION

INDEX TO

SECTION 40 27 05.08 – PIPING APPURTENANCES

SECTION 40 27 05.08

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE

1. This section specifies pipeline thermometers, flow and level gages, pressure gages, strainers, steam traps, vents, and drains.

B. EXCLUSIONS:

1. Temperature, pressure and flow measuring devices used for instrumentation are specified in Other Sections.

PART 2 – PRODUCTS

2.01 PIPELINE THERMOMETERS

A. GENERAL:

1. Pipeline thermometers shall be suitable for the 50 – 150 degrees Fahrenheit. Pipeline thermometers shall indicate fluid temperatures within the pipeline to an accuracy of plus or minus two percent of thermometer full scale.

2. Pipeline thermometers shall be provided with threaded thermowell mountings, designed to permit removal of the thermometer without depressurization or loss of process fluid. For insulated pipes a thermowell with a lagging extension shall be provided.

B. BIMETALLIC THERMOMETERS:

1. Unless otherwise specified, bimetallic type thermometers shall be of the adjustable angle type mounted for convenient viewing. Bimetallic thermometers shall have type 304 stainless steel case. Thermometer dials shall be a minimum of five inches in diameter and shall be equipped with an external adjustment mechanism for zero reset. Bimetallic thermometers shall be Ashcroft Type EH, Marsh Mastertherm, or equal.

C. FILLED THERMOMETERS:

Unless otherwise specified, filled type thermometers shall have minimum scale length of nine inches and shall be of the adjustable angle type mounted for convenient viewing. Filled thermometers shall consist of a type 304 stainless steel frame and a mercury-filled pyrex tube. The thermometer tube shall be recessed into the frame. Filled thermometers shall be Weksler, Taylor, or equal.

2.02 FLOW AND LEVEL GAGES

A. ROTAMETERS:

1. Unless otherwise specified, rotameters for purges and other low capacity services shall be Brooks Sho-Rate "50," Wallace & Tiernan three-inch purge meter, Schutte & Koerting, or equal, with integral needle valve and flow controller. Meter tubes shall be glass, floats shall be stainless steel, and cases shall be aluminum or stainless steel. Unless otherwise specified, meter sizes shall be selected so that the flow rate recommended by the manufacturer of the purged equipment falls within the middle third of the meter scale. Units shall have a 3-inch minimum scale direct reading in the units of flow.

2. Rotameters for high capacity service shall be glass tube-type with a 5-inch scale and stainless steel frame. Flow range shall be as specified and scales shall indicate the units of flow. Rotameters shall be as manufactured by Brooks, Wallace & Tiernan, Schutte & Koerting, or equal.

B. SIGHT GAGES:

1. Sight gages shall be 3/4-inch Penberthy 205 Series, Lunkenheimer Fig. 589, or equal, automatic water gage complete with pyrex gage glass and gage glass protector. Overall length of gages, type of mounting, and orientation of set shall be as specified.

C. FLOW INDICATORS:

1. Flow indicators shall be provided where specified. Each indicator shall consist of a bronze body with threaded ends and a sight glass with rotary wheel. Pressure ratings for flow indicators shall match pipe pressure ratings. Indicators shall be as manufactured by Jacoby-Tarbox, Schutte & Koerting, Eugene Ernst Products, or equal.

2.03 PRESSURE DEVICES

A. GAGE COCKS:

1. Unless otherwise specified, gage cocks shall be Robertshaw 1303, Ashcroft 1095, or equal. The exposed threads of each gage cock shall be protected by a brass plug.

B. PRESSURE GAGES:

1. Unless otherwise specified, pressure gage scales shall be selected so that the normal operating pressure falls between 50 and 80 percent of full scale, shall be 4 1/2-inch, 270-degree movement, 1/2-percent accuracy, full-scale, and suitable for bottom stem mounting. Gages shall have a 316-SS bourdon tube. All gages shall have a 300 series stainless steel case, shatterproof glass, and a 1/2-inch NPT bottom connection.

2. Pressure gages for air, gas, and low-pressure services (0-10 feet) shall be premium grade, heavy-duty bourdon-tube units (bellow type for vacuum) with Delrin bushings and pinion, and stainless steel sector.

3. Gages on liquid service shall be as noted above, except they shall be provided with an internal pulsation dampening system consisting of either a glycerin fill or a silicone fluid fill. Snubbers or orifices shall not be utilized. Gages shall be Ashcroft Duragauge Fig. 1279, Ametek 1981L, or equal.

C. DIAPHRAGM SEALS:

1. Unless otherwise specified, seals shall be diaphragm type with 1/4-inch flushing connection, Type 316 stainless steel body and Type 316L diaphragm. Fill fluid shall be Silicone DC200 unless otherwise specified. Seal shall be Mansfield and Green Type SG, Ashcroft Type 101, or equal.

D. PRESSURE SENSORS

1. Unless otherwise specified, pressure sensors (tubular chemical seals) shall be the in-line full stream captive sensing liquid type. Wetted parts shall be 316 stainless steel. Flexible cylinder shall be Buna-N unless otherwise specified. Seals shall be rated for 200 psi with five-inch SC hysteresis. Seals shall be Ronningen-Petter, Red Valve, or equal.

2. Fill fluid shall be rated for a temperature range of -20 degrees Fahrenheit to 200 degrees Fahrenheit. Capillary tubing shall be armored stainless steel. Fittings shall be provided for vacuum filling of system. Systems that are not factory filled shall be vacuum filled in the field. Filling connections shall be soldered shut after vacuum evacuation and filling.

2.04 STRAINERS

A. AIR AND GAS STRAINERS:

1. Unless otherwise specified, air and gas line strainers shall be Y-pattern, cast iron body, with 40 mesh Monel screens packed with Everdur wool. Bronze bodies shall be provided with copper piping. Air line strainers shall be fitted with a brass blow off cock. Strainers shall be Mueller, Armstrong, or equal.

B. STEAM AND WATER STRAINERS:

1. Steam and water strainers shall be of Y-pattern, unless otherwise specified. Steam strainers shall have carbon steel body; water strainers shall have cast iron body. Bronze bodies shall be provided with copper piping. Strainers shall have 304 stainless steel screens and tapped and plugged blow off connections. Screen perforations shall be 0.020 inch for steam service and 0.045 inch for water service. Strainers shall be Mueller, Armstrong, or equal.

C. FUEL OIL STRAINERS:

1. Fuel oil strainers shall be of the basket type and shall have cast iron body with 304 stainless steel screens. Screen perforation shall be 3/64 inch. Strainers shall be Bailey No. 1, Mueller, or equal.

2.05 PRODUCT DATA

A. Manufacturer's product data shall be submitted for approval.

PART 3 – EXECUTION

3.01 PIPELINE THERMOMETERS

A. Unless otherwise specified, filled thermometers shall be used on all water based services, and bimetallic thermometers shall be used for high temperature (300 degrees F or above) steam or gaseous services. Filled thermometers shall be installed where vibration or unstable mounting conditions exist. Thermometers shall be provided for all water and process stream inlets and outlets at each heat exchanger, heat extractor, and chiller; where shown, and adjacent to process taps for temperature sensing or transmitting instrumentation.

3.02 GAGE TAPS

A. Gage taps shall be provided on the suction and discharge of all pumps, fans, compressors, vacuum pumps and blowers. Gage taps shall consist of a 1/4-inch gage cock attached by a threaded nipple to the pipeline, duct or equipment.

3.03 VENTS AND DRAINS

A. Manual air vents shall be provided at the high points of each reach of pipeline where specified. Air vents shall consist of bronze cock and copper tubing return. Air vents shall be taken to the nearest floor with cock mounted four feet above the floor. Vents in piping systems for fluids containing solids shall be one-inch non–lubricated eccentric plug valves fitted with quick couplers.

B. Drains shall be piped to a sump, gutter, floor drain or other collection point with a valve mounted four feet above the floor. Drain valves shall be threaded end gate valves of the size specified. When drains cannot be run to collection points, they shall be routed to a point of easy access and shall have hose gate valves of the size specified.

END OF SECTION

INDEX TO

SECTION 40 27 05.09 – INSULATION FOR EXPOSED PIPING AND EQUIPMENT

SECTION 40 27 05.09

INSULATION FOR EXPOSED PIPING AND EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies insulation for exposed piping and related equipment and appurtenant surfaces.

2. All above ground lines require insulation (One-inch minimum. See table in 3.02 for specifics).

B. TEMPERATURE CLASSES:

Insulation for exposed piping and equipment is classified for the following temperature ranges: low, medium, high, and very high.

Low temperature class insulation shall be suitable for an operating temperature range of minus 100 to 100 degrees Fahrenheit.

Medium temperature class insulation shall be suitable for an operating temperature range of 100 to 800 degrees Fahrenheit.

High temperature class insulation shall be suitable for an operating temperature range of 800 to 1,200 degrees Fahrenheit.

Very high temperature class insulation shall be suitable for an operating temperature range of 1,200 to 1,800 degrees Fahrenheit.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASTM B209	Aluminum and Aluminum–Alloy Sheet and Plate
ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
ASTM C552	Cellular Glass Thermal Insulation
ASTM E96	Water Vapor Transmission of Materials
FEDSPEC L–P–535E	Plastic Sheet (Sheeting) "Plastic Strip" Poly (Vinyl Chloride) and Poly (Vinyl Chloride–Vinyl Acetate), Rigid
ASTM C547	Mineral Fiber Pipe Insulation

PART 2 –PRODUCTS

2.01 GENERAL

A. Piping insulation shall be tubular type or the flexible blanket type. Insulation for valves, strainers, fittings, expansion joints, flanges and other connections shall be segmented sections, molded, or blanket type coverings of the specified type and thickness of pipe insulation, or the flexible blanket type. Equipment insulation shall be flexible blanket type or rigid board type cut to fit the surface.

2.02 INSULATION

A. GENERAL:

1. Low temperature class insulation shall be of the unicellular elastomeric thermal, cellular glass, or fiberglass type.

2. Medium temperature class insulation shall be of the cellular glass or fiberglass type.

3. High temperature class and very high temperature class insulation shall be of the calcium silicate type or the flexible blanket type. Piping and equipment subjected to vibration (such as engine exhaust) shall be insulated with flexible blanket type.

B. UNICELLULAR ELASTOMERIC THERMAL TYPE:

1. Unicellular elastomeric thermal type insulation shall conform to the requirements of ASTM C534, Type I.

C. CELLULAR GLASS TYPE:

1. Cellular glass type insulation shall conform to the requirements of ASTM C552, Type II.

D. FIBERGLASS TYPE:

1. Fiberglass type insulation shall conform to the requirements of ASTM C547, Type I, Grade A.

E. CALCIUM SILICATE TYPE:

1. Calcium silicate type insulation shall conform to the requirements of ASTM C533, Type II, Class C.

F. FLEXIBLE BLANKET TYPE:

1. HIGH TEMPERATURE CLASS: High temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,200 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, SEI Temp–Set 1200, or equal.

2. VERY HIGH TEMPERATURE CLASS: Very high temperature insulation shall be removable one–inch or two–inch thick blanket–type insulation designed for continuous 1,800 degree Fahrenheit service. The blanket shall be a custom sewn, flexible, reusable jacket, custom designed to closely fit the piping or the equipment housing. Blanket shall be custom–fitted to not restrict access to any instrumentation or equipment. Insulation shall not compact or shake down in vibrating service. Blanket insulation shall consist of a noncombustible silica cloth jacket and high purity alumina and silica nonasbestos white ceramic fiber insulation. Insulating blanket shall be Hitco AIM, Advanced Thermal Products, or equal.

2.03 INSULATION JACKETS

A. LAMINATED JACKETS:

1. Laminated jackets shall consist of aluminum and white kraft paper. Jackets shall have a perm rating for water vapor transmission of not more than 0.02 in accordance with procedure A of ASTM E96.

B. ALUMINUM JACKETS:

1. Aluminum jackets shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Jackets shall be 0.016 inch thick.

2. Sheet metal screws shall be aluminum or stainless steel.

3. Jackets shall be secured with 0.020 by 3/4 inch type 304 stainless steel expansion bands.

2.04 INSULATION COVERS

A. POLYVINYLCHLORIDE (PVC) COVERS:

1. Polyvinylchloride covers shall be one piece, premolded polyvinylchloride.

B. ALUMINUM COVERS:

1. Aluminum covers shall be constructed of smooth finish aluminum sheet conforming to ASTM B209, alloy 5005, 3003, or 3105, temper H16, with integral vapor barrier. Covers shall be 0.016 inch thick.

C. SOFT COVERS:

1. Soft covers shall be of the reusable type with TFE–coated fiberglass covers and liner.

2.05 SHIELDS

A. Unless otherwise specified, thermal pipe hanger shields shall be provided at pipe supports. Thermal hanger shields shall be as specified in Section 40 05 15.

2.06 FLASHING

A. Flashing shall include aluminum caps, sealant and reinforcing. Aluminum caps shall be 20 gage thick and shall be cut to completely cover the insulation. Sealants shall be as recommended by the insulation manufacturer.

B. Reinforcement in flashing heated up to 370 degrees Fahrenheit shall be nylon fabric. Reinforcement in flashing for hotter surfaces shall be wire mesh or as recommended by the insulation manufacturer.

2.07 PRODUCT DATA

A. The following information shall be submitted:

1. Manufacturer and manufacturer's type designation.

2. Samples, for each insulation material type, of typical jacket and closures for fittings, valves and appurtenances.

3. Descriptive literature and catalog data for materials to be used showing methods of installation.

4. Certification of ratings for water vapor transmission and puncture and stiffness as specified in paragraph 40 27 05.09–2.03 A.

PART 3 – EXECUTION

3.01 INSTALLATION

A. GENERAL:

1. Insulation shall be applied over clean, dry surfaces. Double layer insulation, where specified or required to achieve the specified surface temperature, shall be provided with staggered section joints.

B. PIPE SUPPORTS AND SHIELDS:

1. Unless otherwise specified, thermal pipe hanger shields shall be provided by the Contractor and installed during pipe support installation. Where thermal pipe hanger shields are used, apply the following to all butt joints:

   a. On hot pipe systems, the Contractor shall apply three–inch wide vapor barrier tape or band over the butt joints.

   b. On cold water, chilled water, or refrigerant piping, the Contractor shall apply a wet coat of vapor barrier lap cement on all butt joints and seal the joints with a minimum 3–inch wide vapor barrier tape or band.

C. PROTECTION:

1. Insulation and jackets shall be protected from crushing, denting, and similar damage during construction. Vapor barriers shall not be penetrated or otherwise damaged. Insulation, jacket, and vapor barriers damaged during construction shall be removed and new material shall be installed.

D. PIPING INSULATION:

1. GENERAL:

   a. PIPE: Piping shall be continuously insulated along its entire length including all in–line devices such as valves, fittings, flanges, couplings, strainers and other piping appurtenances. Unless otherwise specified, piping insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A. Insulation shall be butted firmly together and jacket laps and joint strips provided with lap adhesive. Jackets shall be provided with their seams located on the underside of pipe.

      1. PVC covers specified in paragraph 40 27 05.09–2.04 A shall not be used with medium– or high–temperature class insulation. Removable flexible blanket–type insulation need not be jacketed.

   b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Fitting, connection, flange and valve insulation shall be provided with covers specified in paragraph 40 27 05.09–2.04. Insulation shall be secured in place with 20–gage wire and a coat of insulating cement. Covers shall overlap the adjoining pipe insulation and jackets. Covers shall be provided with their seams located on the underside of fittings and valves.

2. LOW TEMPERATURE CLASS:

   a. PIPE: Insulation shall have ends sealed off with a vapor barrier coating.

   b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, insulation for pipe sizes two inches and less, shall be provided with rigid PVC covers specified in paragraph 40 27 05.09–2.04 A. Covers shall be sealed at edges with vapor barrier adhesive. The ends of covers shall be secured with vinyl tape. The tape shall overlap the jacket and the cover at least one inch. Vapor barrier shall not be penetrated.

      1. Except where soft covers are specified, insulation for pipes two and a half inches and larger shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

3. MEDIUM, HIGH, AND VERY HIGH TEMPERATURE CLASS:

   a. PIPE: Except for flexible blanket type, insulation shall have ends sealed with end joint strips and held in place by waterproof adhesive.

   b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Except where soft covers are specified, rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Covers shall be mechanically secured by corrosion–resistant tacks pushed into the overlapping throat joint.

4. OUTDOOR PIPING:

   a. PIPE: Rigid insulation shall be provided with aluminum jackets specified in paragraph 40 27 05.09–2.03 B. Flexible blanket–type insulation shall be designed for outdoor, weather–exposed service.

   b. FITTINGS, CONNECTIONS, FLANGES AND VALVES: Rigid insulation shall be provided with rigid aluminum covers specified in paragraph 40 27 05.09–2.04 B. Flexible blanket type insulation shall be designed for outdoor, weather–exposed service.

E. MECHANICAL EQUIPMENT INSULATION:

1. GENERAL: Unless otherwise specified, insulation shall fit the contours of equipment and shall be secured with 1/2 by 0.015 inch galvanized steel bands. Weld pins or stick clips with washers may be used for flat surfaces

and spaced a maximum 18 inches apart. Joints shall be staggered and voids filled with insulating cement. Unless otherwise specified, insulation shall be provided with laminated jackets specified in paragraph 40 27 05.09–2.03 A.

a. Unless specifically specified to be uninsulated, equipment connected to insulated piping shall be insulated.

2. OUTDOOR EQUIPMENT: Insulation shall be provided with a coat of weatherproof mastic and a layer of open–weave glass cloth embedded into a wet tack coat. Seams shall overlap at least two inches. A finish coat of weatherproof mastic shall be provided. The total coating thickness shall be a minimum of 1/8-inch.

3. LOW TEMPERATURE CLASS: Insulation shall have joints, breaks, and punctures sealed in facing with fire–retardant vapor barrier adhesive reinforced with four–inch tape.

   Insulation shall be provided with a layer of open–weave glass cloth embedded into a wet coat of fire–retardant adhesive. Seams shall overlap at least two inches. A finish coat of fire–retardant adhesive shall be provided.

4. MEDIUM TEMPERATURE CLASS: Joints shall be covered and cemented in place with four–inch–wide strips of the same material as the laminated jackets specified in paragraph 40 27 05.09–2.03 A.

5. HIGH AND VERY HIGH TEMPERATURE CLASS: High and very high temperature equipment shall be covered with custom–fitted removable blanket–type insulation. Blanket–type insulation shall be secured with stainless steel wire lacing and hooks. Ends of blanket segments shall overlap to prevent gaps and voids when the piping and equipment is heated. Blankets shall be snugly secured under nuts and bolt heads to assure complete coverage during operation and to prevent vibration–induced gaps or voids. Blankets shall be secured in strict accordance with the manufacturer's instructions.

F. FLASHING:

1. Flashing shall be provided at jacket penetrations and terminations. Clearance for flashing shall be provided between insulation system and piping supports.

2. A heavy tack coat of sealant shall be troweled over the insulation, extending over the jacket edge 1 inch and over the pipe or protrusion 2 inches. Reinforcement shall be stretched over the tack coat after clipping to fit over pipe and jacket. Clipped reinforcing shall be strapped with a continuous band of reinforcing to prevent curling. Sealant shall then be troweled over the reinforcement to a minimum thickness of 1/8-inch.

3. Aluminum caps shall be formed to fit over the adjacent jacketing and to completely cover coated insulation. Cap shall be held in place with a jacket strap.

3.02 INSULATION THICKNESS SCHEDULE

A. The insulation dimensional tolerances shall comply with the specified standards. Equipment insulation shall match thickness of attached piping. The minimum insulation thicknesses, exclusive of jacket, shall be as follows:

Piping service	Fluid temperature range, degrees F	Insulation thickness in inches for nominal pipe sizes					
		Runouts up to 2 inches	1 inch and less	1.25 to 2 inches	2.50 to 4 inches	5 and 6 inches	8 inches and larger
Cooling:							
Refrigerant	25–40	1.0	1.0	1.0	1.0	–	–
Process:							
Water & similar	60-100	1.0	1.0	1.5	1.5	1.5	2.0
PA, CA[f]	150–250	1.0	1.0	1.5	1.5	1.5	–
NaOH	60 – 100	1.0	1.0	1.0	–	–	–

a. See specification Section 40 27 05.
b. Runouts to individual terminal units (not exceeding 12 feet in length).
c. Refrigerant insulation by air conditioning equipment supplier.
d. Insulate piping for personnel protection between compressor and after cooler only. Include drip legs.
e. For condensation control, see specification Section 40 27 05. Unless otherwise specified, connected equipment shall be uninsulated.
f. All above ground lines require a 1-inch minimum thick insulation.

END OF SECTION

INDEX TO

SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

SECTION 40 29 01

MANUAL VALVE AND GATE OPERATORS AND OPERATOR APPURTENANCES

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies manual operators for valves and gates, and operator appurtenances.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

B. Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
AWWA C500	Gate Valves 3 through 48-inch NPS, for Water and Sewage Systems

PART 2 – PRODUCTS

2.01 GENERAL

A. Except as specified in valve and gate specification sections, manual operators shall be as specified herein. Operators shall be mounted on the valve or gate and provided as a unit. Each valve body or operator shall have cast thereon the word "OPEN," an arrow indicating the direction to open, and flow direction arrows.

2.02 OPERATORS

A. GENERAL:

1. Manual operators shall have operating torques less than 80 foot–pounds. Unless specified otherwise, each manual operator shall be provided with an operating wheel. Unless specified otherwise, the direction of rotation of the operator shall be counterclockwise for opening.

B. WRENCH NUTS:

1. Wrench nuts shall comply with Section 3.15 of AWWA C500. A minimum of two operating keys, but no less than one key per every ten valves, shall be provided for operation of the wrench nut operated valves.

C. CHAIN WHEELS:

1. Chain wheels shall be ductile iron. Operating chains shall be **stainless steel.**

2.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes shall be cast iron and shall have suitable base castings to fit properly over the bonnets of their respective valves and heavy top sections with stay–put covers.

B. FLOOR BOXES:

1. Floor boxes shall be hot–dip galvanized. Where the operating nut is in the concrete slab, the floor box shall be bronze bushed. Where the operating nut is below slab, the opening in the bottom of the box shall be sufficient for passage of the operating key.

C. ADJUSTABLE SHAFT VALVE BOXES:

1. Adjustable shaft valve boxes shall be concrete or cast-iron Brooks No. 3RT, Christie G5, Empire 7–1/2 valve extension box, or equal. Box covers on water lines shall be impressed with the letter "W." Gas line covers shall be impressed with the letter "G."

2.04 PRODUCT DATA

A. Manufacturer's catalog information and other data confirming conformance to design, and material requirements shall be provided.

PART 3—EXECUTION

3.01 GENERAL

A. Installation shall be as specified herein. Valve operators shall be located so that they are readily accessible for operation and maintenance. Valve operators shall be mounted for unobstructed access but mounting shall not obstruct walkways. Valve operators shall not be mounted where shock or vibration will impair their operation. Support systems shall not be attached to handrails, process piping, or mechanical equipment.

3.02 OPERATORS

A. GENERAL:

1. Valves and gates shall be provided with manual operators, unless specified otherwise. Where possible, manual operators shall be located between 48 inches and 60 inches above the floor or a permanent work platform.

B. WRENCH NUTS:

1. Wrench nuts shall be provided on buried valves, on valves which are to be operated through floor boxes, and where specified. Extended wrench nuts shall be provided if necessary so that the nut will be within six inches of the valve box cover.

C. CHAIN WHEELS:

1. Unless otherwise specified, valves with centerlines more than seven feet, six inches above the specified operating level shall be provided with chain wheels and operating chains. Chain wheel operated valves shall be provided with a chain guide. Operating chains shall be looped to extend within four feet of the specified operating level below the valve. For plug–type valves eight inches and larger, the operator shall be provided with a hammer blow wheel. Hooks shall be provided for chain storage where the chain may hang in a walkway.

3.03 OPERATOR APPURTENANCES

A. VALVE BOXES:

1. Valve boxes extending to finished surfaces shall be provided for buried valves.

B. FLOOR BOXES:

1. Floor boxes shall be provided for wrench operation of valves located below concrete slabs. Each floor box and cover shall be of the depth required for installation in the slab.

END OF SECTION

INDEX TO

SECTION 40 29 13 – BUTTERFLY VALVES

SECTION 40 29 13

BUTTERFLY VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies butterfly valves for air, gas, steam, and water service.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800
ANSI B16.5	Pipe Flanges and Flanged Fittings
ASTM A48	Gray Iron Castings
ASTM A108	Steel Bars, Carbon, Cold–Finished, Standard Quality
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A216/A216M	Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber–Seated Butterfly Valves

PART 2 – PRODUCTS

2.01 MATERIALS

A. Valves specified for use in Water shall be considered TYPE A and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A276, Type 304 Carbon steel, ASTM A108, with stainless steel journals
Disc	Ductile iron, ASTM A536, or cast iron, ASTM A436, type 1 (Ni–Resist); or ASTM A48, Class 40, or ASTM A126, Class B
Seat mating surface	Stainless steel, ASTM A276, Type 304, mounted in body or on disc edge; or Ni–Chrome on the disc edge
Seat sealing surface	Neoprene, EPDM or Buna N
Body	Cast iron, ASTM A126, Class B

B. Valves specified for use in Air shall be considered TYPE B and shall be constructed of the following materials unless otherwise specified:

Component	Material
Shaft	Stainless steel, ASTM A582, Type 416
Disc	Cast iron, ASTM A126, Class B
Seat sealing surface	Neoprene or Buna N—air and gas services Nordel—(high temp water)
Body	Cast iron, ASTM A126, Class B
Disc edge	Nickel

2.02 MANUFACTURE

A. GENERAL:

1. Valves shall be the stub or through shaft design. Wafer type valves are not acceptable for buried service. Unless otherwise specified, valve flange drilling shall be per ANSI B16.1, Class 125.

B. TYPE A:

1. Type A valves shall be designed in accordance with AWWA C504. Shafts shall be turned, ground and polished. Shaft dimensions and operator torque shall be chosen for the pressure specified in Section 40 27 05 and Class B as specified in AWWA C504. When carbon steel shafts and stainless steel journals are used, static seals shall be provided to isolate the interior of the disc and the shaft from the process fluid.

2. Type A valves, size 3 through 72 inches, shall have seats that are vulcanized, bonded, mechanically secured, or clamped to the body or disc.

C. TYPE B:

1. Valves shall be rated at 175 psig and provide drip tight shutoff up to the full valve rating on dead–end or isolation service. Seat shall be mechanically held in place and shall be field replaceable. Valve ends shall be as specified in Section 40 27 05.

2. Type B valves, size 2 through 20 inches, shall have seats that are bonded to a rigid reinforcing ring.

2.03 MANUAL OPERATORS

A. GENERAL:

1. Manual operators shall be designed in accordance with AWWA C504 and shall have a disc position indicator designating the opened and closed position of the valve.

B. TYPE A:

1. Manual operators for Type A valves shall be of the traveling nut, rack, and pinion, or worm gear type. Operators shall be equipped with adjustable mechanical stop–limiting devices to prevent over travel of the disc in the open and closed positions and shall be self–locking and designed to hold the valve in any intermediate position between full open and full closed. Valve operator components shall withstand an input torque of 300 ft.–lbs. at the extreme operator positions without damage.

2. Operator for buried service shall include an AWWA operating nut and shall be gasketed and grease packed for submerged operation at water pressures to 10 psig. Operators for exposed service shall include a hand wheel and be gasketed for weatherproof service.

C. TYPES B:

1. Operators for Type B valves six inches in diameter and smaller shall be latch lock levers. Valves shall be capable of being locked in at least five intermediate positions between fully open and fully closed.

2.04 PRODUCT DATA

A. Affidavits of compliance with AWWA C504 for Type A valves shall be provided.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 29 19 – ECCENTRIC PLUG VALVES

SECTION 40 29 19

ECCENTRIC PLUG VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

This section specifies eccentric plug valves.

1.02 QUALITY ASSURANCE

A. References – This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM A436	Austenitic Gray Iron Castings
ASTM A536	Ductile Iron Castings
AWWA C504	Rubber Seated Butterfly Valves

B. Proof of Design Tests – The Contractor shall furnish the Construction Manager and Engineer of Record three certified copies of a report from an independent testing laboratory certifying successful completion of proof–of–design testing conducted in accordance with AWWA C517–05, except that where the word "disc" appears in the standard, it is understood to mean "plug." In lieu of testing the valves at an independent testing laboratory, proof–of–design testing may be performed at the valve manufacturer's laboratory but must be witnessed by a representative of a qualified independent testing laboratory, and all test reports must be certified by the laboratory representative. Proof–of–design testing shall have been performed on not less than three 6–inch diameter valves, with all three test units demonstrating full compliance with the test standards. Failure to satisfactorily complete the test shall be deemed sufficient evidence to reject all valves of the proposed make or manufacturer's model number.

PART 2 – PRODUCTS

2.01 MATERIALS

Materials of construction shall be as follows:

Component	**Material**
Body	Cast iron, ASTM A126, Class B
Plug	Cast iron, ASTM A126, Class B, or cast-iron ASTM A436 (Ni–resist), or ductile iron, ASTM A536
Plug facing	Neoprene or Buna–N
Body seats	
Less than 3 inches	Cast iron, ASTM A126, Class B
3 inches and larger	Stainless steel, ASTM A276, Type 304 or nickel
Packing	Buna V–flex or TFE

Materials specified are considered the minimum acceptable for the purposes of durability, strength, and resistance to erosion and corrosion. The Contractor may propose alternative materials for the purpose of providing greater strength or to meet required stress limitations. However, alternative materials must provide at least the same qualities as those specified for the purpose.

2.02 MANUFACTURER

A. General – Valves shall be straight–flow, non–lubricated, resilient plug type suitable for drip-tight, bi–directional shutoff at the specified valve design pressure. Port areas for the valve shall be at least 80% of the adjacent full pipe area. Valve body seats consisting of nickel for valves three inches and larger shall be constructed of a welded–in overlay of not less than 90% pure nickel. Upper and lower journal bearings shall be replaceable, sleeve–type, corrosion resistant, and permanently lubricated. Packing shall be self–adjusting, chevron-type, replaceable without disassembling the valve. ***The valve shall be manufactured by Dezurik***. No other valves are acceptable.

Unless otherwise specified, valves shall, as a minimum, conform to the following pressure ratings:

Size, inches	Design pressure, psig
12 and smaller	175
14 through 36	150
42 through 54	125

B. End Connections – Valves three inches and smaller shall have threaded ends. Valve flange drilling for valves larger than three inches shall be per ANSI B16.1, Class 125. Grooved–end valves may be provided with grooved–end piping systems.

C. Manual Operators – Unless otherwise specified, valves four inches and smaller shall be provided with a lever type manual operator. Valves larger than four inches shall be provided with totally enclosed worm gear operators. Where specified, manual operators shall have an adjustable stop. All operator components shall be sized for the valve design pressure in accordance with AWWA C504, Section 4.5. Operators shall comply with applicable portions of Section 40 29 01.

2.03 MOTORIZED ACTUATOR FOR ATTACHED TO PLUG VALVES (14", 24" and 30" Plug Valves & 30" Knife Gate Valve)

See Specification Section 40 29 50 (Specialty Valves) for all the actuators specification.

2.04 PRODUCT DATA

The following information shall be provided:

A. Manufacturer's product data.

B. Proof–of–design test reports specified in paragraph 40 29 19–1.02 B.

PART 3 – EXECUTION

Unless otherwise specified, valves shall be provided with the seat downstream away from flow. Valves at tank connections shall be installed with seat away from tank. Valves on pump discharge lines shall be installed with seat adjacent to the pump.

END OF SECTION

INDEX TO

SECTION 40 29 27 – NONCLOG BALL CHECK VALVE

Paragraph **Title** **Page**

SECTION 40 29 27

NONCLOG BALL CHECK VALVE

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

1. This section specifies nonclog ball check valves.

B. TYPE:

1. The nonclog check valves shall consist of three components: body, cover, and ball—one moving part. The design of the valve shall keep solids, stringy material, grit, rags, etc., moving without the need for backflushing. The ball shall clear the waterway providing "full flow" equal to the nominal size. There shall be no outside levers, weights, springs, dashpots, or other accessories.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, and 800

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. The following candidate manufacturers are capable of producing equipment and/or products that will satisfy the requirements of this Section. This statement, however, shall not be construed as an endorsement of a particular manufacturer's products, nor shall it be construed that named manufacturers' standard equipment or products will comply with the requirements of this Section. Candidate manufacturers include Flygt and Golden Anderson, or equal.

2.02 COMPONENTS

A. BODY AND COVER:

1. Valve body and cover shall be of gray cast iron or ductile iron. Flange drilling shall be according to ANSI B16.1, Class 125.

B. BALL:

1. The valve ball shall be hollow steel with an exterior of nitrile rubber. It shall be resistant to grease, petroleum products, animal and vegetable fats, diluted concentrations of acids and alkalines (pH 4 to 10), tearing, and abrasion.

2.03 PRODUCT DATA

A. Submit product information and applicable operation and maintenance information for review.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 29 50 – SPECIALTY VALVES & MOTORIZED ACTUATORS

SECTION 40 29 50

SPECIALTY VALVES & MOTORIZED ACTUATORS

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section specifies specialty valves which are auxiliary to process piping systems.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. Where a referenced document contains references to other standards, those documents are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

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Reference	Title
ASME SEC VIII D2	Boiler and Pressure Vessel Code, Pressure Relief Devices
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings

PART 2 – PRODUCTS

2.01 MUD VALVES

A. Mud valves shall be of the heavy-duty flange type with rising or non-rising stems as shown on the plans. Frame, cover, yoke and stem extension connection shall be stainless steel. Stems shall be stainless steel. Lift nuts shall be bronze. On non-rising stem models the stem is to be protected by a stainless-steel shroud with drain hole. Valve shall be operated by a tee handle, hand wheel, or with stainless (mild steel) stem extension to the height required. On rising stem valves, stem guides shall be provided such that the L/R ratio of the unsupported part of the stem shall not exceed 200. Pedestal lifts, stem guides, and wall brackets shall be furnished by mud valve manufacturer to make a complete and operable unit. Mud valves shall be Waterman MV–11, Trumbull 367-1351 or equal.

2.02 PRESSURE RELIEF VALVES

A. Pressure relief valves for air shall be ASME certified, Watts Fig 41A, Lonergan L14/L40 Series, or equal. Size and pressure settings shall be as specified or as required for the service intended. Pressure relief valves for cold and hot water shall be McDonnell and Miller 230, Watts 174A, Cash Acme F–82, Lonergan L14/L40 Series, or equal.

2.03 HOSE VALVES

A. Unless specified otherwise, hose valves shall be a brass angle valve, composition disc, Crane 17, Lunkenheimer 214, Powell 151, or equal with threaded nipple adapter for hose connection.

2.04 FLUSHING COCKS

A. Flushing cocks shall consist of a DeZurik 159/118–S, Keystone Fig 541, or equal, neoprene–faced eccentric plug valve with a hose nipple adapter if required. Unless specified otherwise, flushing cocks shall be 1 inch in diameter.

2.05 KNIFE GATE VALVES (AT GRIT SYSTEM)

A. Design features and materials of construction for service condition at wastewater application.

i. Fully lugged body design providing uni-directional shutoff.

ii. Working Pressure Rating: 150 psi for valves 2" to 24"; 100 psi for 30" and 36".

iii. Body: Round port, single piece cast stainless steel body (316SS) and shall be equipped with a minimum of 3 flush ports valves (at 3, 6, and 9 O'clock positions) to allow for cleaning of solids trapped within the body cavities that can be flushed with plant reuse water (holes drilled and tapped, piping by the G.C).

iv. Gate: Stainless steel (fully machined) gate, material to be same as body with 60-degree V-port

v. Stem: 303/430 stainless steel, single start trapezoidal thread.

vi. Seats: Shall be made of EPDM material, and mechanically held in place by means of a stainless-steel seat retainer ring, no adhesives or O-ring style seats shall be permitted.

vii. Packing: Shall be PTFE impregnated synthetic fibre (ST) with EPDM O-ring, retained by a one-piece cast stainless steel (same as body material) packing gland which shall be fully accessible for maintenance purposes.

viii. Ends: Flange connection shall be per ANSI B16.5 Class 150.

ix. Yoke: One-piece formed 316 S.S.

x. Operator: non-Rising stem manual hand wheel, one-piece upper stem protector shall be included. (Non-rising stem, stem extensions, automation requirements as specified per project requirements.)

xi. Factory pressure and leak test per MSS-SP 81.
Non-Bonneted (standard) and Bonneted (fabricated) models available, please specify with pressure rating required.

xii. Acceptable manufacturers:

The knife gate valve shall be **Orbinox** – Model series 20 or **Dezurik**

2.06 MOTORIZED ACTUATOR FOR 30" KNIEF GATE VALVE (2 Each)

The motorized actuator shall be **Limitorque-MXa**-40/MOD for attachment to a knife gate valves with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 225 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA14 MSS MOUNTING BASE
- 1.82" MAXIMUM BORE w/1/2 x 1/2 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 104 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE V-3 BEVEL GEARBOX
- 5:1RATIO
- FA16 MSS MOUNTING BASE
- 2.83" MAX STEM ACCEPTANCE
- 1844 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

Adaption Specifications:
MOUNTING TO KNIFE GATE VALVE INCLUDES
- ADAPTION TO VALVE
- MACHINING ACTUATOR TORQUE NUT
- MACHINING GEARBOX STEM NUT

2.07 MOTORIZED ACTUATOR FOR 14" PLUG VALVES (1 Each)

The motorized actuator shall be **Limitorque-MXa**-20/MOD electric actuator 18 RPM NEMA 4X enclosure for attachment to a 14" Plug valve at RAS pump station coupled to a WG-04-B Gearbox with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 125 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA10 MSS MOUNTING BASE
- 1.25" MAXIMUM BORE w/1/4 x 1/4 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 49.5 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE WG-06-1SD-B GEARBOX
- 252:1 RATIO
- FA25 MSS MOUNTING BASE
- 3.25" MAX STEM ACCEPTANCE
- 767 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

2.08 MOTORIZED ACTUATOR FOR 24" PLUG VALVES (6 Each)

The motorized actuator shall be **Limitorque-MXa**-20/MOD B4 77 RPM for attachment to a 24" Plug valves (2 at RAS pump station, and 4 at influent lines to screens) coupled to a WG-04-1SD-B Gearbox with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 125 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA10 MSS MOUNTING BASE
- 1.25" MAXIMUM BORE w/1/4 x 1/4 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 49.5 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE WG-06-1SD-B GEARBOX
- 252:1 RATIO
- FA25 MSS MOUNTING BASE
- 3.25" MAX STEM ACCEPTANCE
- 767 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

2.09 MOTORIZED ACTUATOR FOR 30" PLUG VALVES in Manhole (2 Each)

The motorized actuator shall be **Limitorque-MXa**-10/STD B4 for attachment to a 30" Plug valves in manhole (actuators and electrical components & wiring shall be rated for submergence in 10ft. of water) coupled to a WG-06-1SD-B Gearbox with the following specifications:

- 3/60/460 VAC CONNECT VOLTAGE W/0.99 HP MOTOR
- 125 FT-LBS OF TORQUE CAPABLE
- 5 ASSIGNABLE CONTACTS - O(A) CONFIGURATION
- ABSOLUTE ENCODER (SENSES POSITION OF ACTUATOR)
- ELECTRONIC TORQUE SENSING
- 32 CHARACTER LCD DISPLAY
- INTERNAL MOTOR CONTROLS
- LOCAL CONTROL STATION (LOCKABLE)
- MANUAL DECLUTCH (LOCKABLE)
- FA10 MSS MOUNTING BASE
- 1.25" MAXIMUM BORE w/1/4 x 1/4 SQ KEY
- WP (WEATHER PROOF), NEMA 4, 4X & 6
- 94.5 SECONDS ESTIMATED STROKE TIME

Gearbox Specifications:
NEW LIMITORQUE WG-06-1SD-B GEARBOX
- 768:1 RATIO
- FA10 MSS MOUNTING BASE
- 2.83" MAX STEM ACCEPTANCE
- 24190 FT-LBS MAX TORQUE CAPABLE
- 64,745 LBS MAX THRUST CAPABLE

2.10 TELESCOPING VALVES

A. Contractor to furnish and install four (4) 24" tube diameter telescoping valves to fit onto a 24" RAS piping as shown on the plans. The valve body shall be 316 stainless steel. The lifting straps shall be the same material as tube with flared tube tops. The wiper gasket shall be Neoprene to provide a friction seal around the sliding tube. The stem and operator shall also be 316 S.S.

The lift and stems shall be handwheel type, with UHMW polyethylene thrust bearings along with a stub acme threaded type 316 stainless steel stem to provide automatic self-locking, infinite valve positioning. If needed, a vee keyed shaft, with torque plate, shall be used to prevent valve tube rotation. Handwheels shall be a minimum of 12" in diameter and shall include a clear plastic Butyrate stem cover with a mylar strip type position indicator, calibrated in ¼ inch increments to illustrate valve position. The mylar strip, provided by the manufacturer, will be affixed by the contractor after installation to provide a true and accurate indication of the tube elevation by comparing it to the top of the rising stem. Stainless steel anchor bolts shall be provided for all pedestals.

The telescoping valves shall be manufactured by **Waterman** or approved equivalent.

2.11 QUICK DISCONNECTS

B. Quick disconnects shall not be disconnectable under pressure. Quick disconnects for air service shall be Swagelok, Tomco, or equal, and shall be 1/2 inch, unless otherwise specified. Quick disconnects for water service shall be EverTite Part B, Gate Part B, or equal, and shall be 1 inch, unless specified otherwise.

2.12 PRODUCT DATA

A. Provide product data for approval.

PART 3 – EXECUTION

3.01 EXECUTION

A. Specialty valves shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 31 00

FABRICATED STAINLESS STEEL SLIDE & WEIR GATES

SECTION 40 31 00

FABRICATED STAINLESS-STEEL SLIDE & WEIR GATES

PART 1 – GENERAL

1.01 DESCRIPTION

A. SCOPE:

This section specifies heavy-duty, self–contained Stainless Steel Downward Opening Weir Gates and gate operators and upward opening slide gates for MBR tanks and the splitter box.

B. TYPE:

Slide gates shall be of fabricated stainless-steel heavy-duty construction, with gates, guides, and operators provided by one manufacturer. Gates shall meet the leakage requirements of AWWA C561.

The equipment provided under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the engineer.

Gates and operators shall be supplied with all the necessary parts and accessories indicated on the drawings, specified or otherwise required for a complete, properly operating installation and shall be the latest standard product of a manufacturer regularly engaged in the production of water control gates.

C. DESIGN CONDITIONS:

Self–contained slide gates shall be designed for continuous exposure to raw municipal wastewater. Fluid temperature is expected to range from 60 degrees F to 80 degrees F. The gates will be installed outdoors in a municipal wastewater treatment plant near the ocean.

D. OPERATING REQUIREMENTS:

Equipment number	Gate size, inch (a)	Gate type (b)	Opening direction (c)	Bottom seating (d)	Design head, feet		Operator type (e)
					Seating	Unseating	
WG–101 (MBR 1)	60 x 24	W	D	SA [1]	1	0	HW [2]
WG–102 (MBR 2)	60 x 24	W	D	SA [1]	1	0	HW [2]
WG–103 (MBR 3)	60x 24	W	D	SA [1]	1	0	HW [2]
WG–104 (MBR 4)	60 x 24	W	D	SA [1]	1	0	HW [2]
SG – 201-Splitter	60 X 18	W	U	SA [1]	1	0	HW [2]

Equipment number	Gate size, inch (a)	Gate type (b)	Opening direction (c)	Bottom seating (d)	Design head, feet		Operator type (e)
					Seating	Unseating	
SG – 202- Splitter	60 X18	W	U	SA (1)	1	0	HW (2)

Notes:

SA (1) =Self-adjusting UHMW seal along the invert
HW (2) =hand wheel-operated gearbox type

[a] Width by height.
[b] C = channel–mounted, W = wall–mounted
[c] U = upward, D – downward
[d] FB = flush bottom, J = J–seal on invert
[e] GC = geared crank type, HW = hand wheel type

1.02 QUALITY ASSURANCE

A. REFERENCES:

This section contains references to the following documents. They are a part of this section as specified and modified. In case of a conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Notice Inviting Bids. If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, whether or not the document has been superseded by a version with a later date, discontinued or replaced.

Reference	Title
ASME	American Society of Mechanical Engineers
ASTM 240	Heat–Resisting Chromium and Chromium Nickel Stainless Steel Platé, Sheet, and Strip for Pressure Vessels
ASTM A276	Stainless and Heat–Resisting Steel Bars and Shapes
ASTM D1248	Polyethylene Plastics Molding and Extrusion Materials for Wire and Cable
ASTM D2000	Rubber Products in Automotive Applications
ASTM D4020	Ultra–High–Molecular–Weight Polyethylene Molding and Extrusion Materials
AWWA C561	Open–Channel, Fabricated Metal Slide Gates

B. SUBMITTALS:

The following information shall be submitted for approval:

1. 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 Engineer 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.

2. Fabrication drawings with full dimensions.

3. Plan, cross section, and details showing proposed mounting for each size and typical application of gate.

C. MANUFACTURING:

Manufacturer's welders shall be certified per ASME, Section 1X or American Welding Society.

D. EXPERIENCE:

Manufacturer shall have a minimum of ten years' experience with the fabrication of the model of gate provided. Submit installation list of the model of gate provided to confirm this requirement.

PART 2—PRODUCTS

2.01 PRODUCTS

Fabricated stainless-steel weir gates shall be RW Gate Company, Golden Harvest, Hydro Gate, Rodney Hunt, Fontaine, Waterman, or equal, modified as necessary to provide the specified features and to meet the specified operating conditions.

2.02 MATERIALS

Materials for components shall be as follows:

Component	Material
Frames, slides, rails, and yokes	ASTM A276 or ASTM A240, Type 316L Stainless Steel
Fasteners and anchor bolts	ASTM A276, Type 316 Stainless Steel
Stems	ASTM A276, Stainless Steel, Type 316
Stem Guides	ASTM A276, Stainless Steel, Type 316L, with bronze or UHMW Polyethylene bushing
Seals	ASTM D2000, Grade AA625, Buna–N or neoprene rubber, or ASTM D4020 UHMW Polyethylene

2.03 EQUIPMENT FEATURES

A. GENERAL DESIGN. Weir gates shall be self–contained, and of the rising stem or non–rising stem configuration. Design stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the materials at maximum load conditions. Minimum thickness of slide, its reinforcing members, and all structural components of the guide and frame shall be 0.25 inches.

B. FRAME. The gate frame shall be constructed of structural members or formed plate welded to form a rigid one–piece frame. The frame shall be of the flange back design, suitable for mounting on a concrete wall (CW). The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene).

C. SLIDE. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head. The gate frame shall be a rigid, welded unit, composed of the guide rails, cross bars, and deadrails, with a clear opening the same size as the waterway, unless otherwise specified. They shall be integral flange back or embedded type. The guides will be of sufficient length to support two–thirds (2/3) the height of the slide, when the gate is fully open. On wall mounted gates, compressible gaskets or grout shall be provided between frame and wall as needed to ensure full mating of surfaces and no leakage.

Where the guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcing will be required. The yoke to support the operating device shall be formed by members welded or bolted at the top of the guides. The arrangement of the yoke shall be such that the slide and stem can be removed without disconnecting the yoke. When the slide is too long to allow this, the yoke shall be bolted for easy removal.

D. GUIDES AND SEALS. The guides shall be made of UHMWPE (ultra high molecular weight polyethylene) and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

The bottom and side seals shall be made of UHMWPE (ultra high molecular weight polyethylene) of the self–adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and let the water flow only in the open part of the gate.

Seals shall maintain the specified leakage rate in both seating and unseating conditions.

E. OPERATOR STEM AND COUPLINGS. The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 40 lbs (178 N) effort on the crank or hand wheel.

The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machine cut threads of the Acme type.

For stems in more than one piece and with a diameter of 1 ¾ inches (45 mm) and larger, the different sections shall be joined together by solid bronze couplings. Stems with a diameter smaller than 1 ¾ inches, shall be pinned to an extension tube.

The couplings shall be grooved and keyed and shall be of greater strength than the stem.

Gates having width equal to or greater than two times their height shall be provided with two lifting mechanisms connected by a tandem shaft.

F. STEM GUIDES. Stem guides shall be fabricated from type 316L stainless steel. The guide shall be equipped with an UHMWPE bushing. Guides shall be adjustable and shall be spaced in accordance with the manufacturer's recommendation. The L/r ratio shall not be greater than 200.

G. STEM COVER. Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

H. LIFTING MECHANISM. Manual operators of the types listed in the schedule shall be provided by the gate manufacturer.

Operators shall be hand wheel type. Operators shall meet AWWA C501 specifications, except as otherwise specified. Gears, and bearings shall be enclosed in a weatherproof housing, and pressure type fittings shall be provided for grease lubrication of the bearings and gears. A maximum effort of 40 pounds pull of the crank or hand wheel shall operate the gate under the specified operating conditions.

The operator shall be either pedestal or bench mounted as specified. Pedestal type floor standards shall be the offset type or the standard type with wall mounting bracket. Pedestal or bench stands shall be cast iron. The head of the pedestal or bench stand operator shall have a solid bronze, internally threaded operating nut. The operator shall be mounted on anti friction roller bearings. Cranks and handwheels shall be removable from the operator. Hand crank operators shall be provided with a 2–inch AWWA operating nut in horizontal appropriate for use with portable electric operators.

I. YOKE. Self–contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span. The yoke shall be sufficiently strong to support the lift forces when subjected to a load of 100 pounds pull on the operator. The yoke shall be designed so that its deflection under full operating load will not exceed 1/360 of the gate width.

J. MATERIALS

PART	MATERIAL
Frame, yoke, stem guides, slide, stem extension	Stainless steel ASTM A–240 type 316L
Guides, side and bottom seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE) ASTM D–4020
Compression cord	Nitrile ASTM D2000 M6BG 708, A14, B14, E014, E034
Threaded stem	Stainless steel ASTM A–276 type 303 MX or 316
Fasteners	ASTM F593 and F594 and GR2 for type 316
Pedestal, hand wheel and crank	Tenzaloy aluminum
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM D–3935
Lift nut, couplings	Manganese bronze ASTM B584 UNS–C86500

In addition to the above, the gates shall meet the followings;

1. All wall mounted frames shall have a minimum guide weight of 13 pounds per foot. The portion of the frame, where the anchor penetrates, shall have a minimum thickness of 1/2-inch.
2. The guide extensions shall have a minimum weight of 6 pounds per foot and shall be constructed of formed plate. Angles are not acceptable for guide extensions.
3. The yoke members shall be C-channel structural members. Angles are not acceptable for yoke members.

4. The portion of the slide, that engages the frame, shall have a minimum thickness of 1/2-inch.
5. The stem shall have a minimum diameter of 1-1/2 inches.

2.04 PRODUCT DATA

The following information shall be submitted for approval:

1. Product information, charts, or graphs to verify that the product provided meets the requirements set forth in the specification.

2. Affidavits of compliance in accordance with AWWA C561.

3. Applicable operation and maintenance.

PART 3—EXECUTION

3.01 INSTALLATION

Unless otherwise specified, self–contained slide gates shall be installed in accordance with manufacturer's instructions.

3.02 TESTING

For purpose of this specification, field leakage tests shall be performed as specified in Section 6.3 of AWWA C513.field leakage tests shall be conducted with no head on one side of the gate being tested.

Gate shall be operated through a minimum of two cycles, to confirm operation. Limit switches and other stops shall be adjusted per the manufacturer's recommendations.

END OF SECTION

INDEX TO

SECTION 40 31 05 – FRP WEIRS

SECTION 40 31 05

FRP WEIRS

PART 1 – GENERAL

1.01 DESCRIPTION

SCOPE:

This section provides detailed specifications for weirs fabricated from fiber reinforced thermoset plastic (FRP).

1.02 QUALITY ASSURANCE

A. REFERENCE:

1. The FRP items to be provided under this section shall meet the applicable requirements of AWWA F102–96, Type II.

B. SERVICE CONDITIONS:

1. The weirs to be furnished under this specification will be installed in a membrane bioreactor tank in a municipal wastewater treatment plant. The wastewater is expected to contain finely divided organic solids, dilute industrial solvents and petroleum products, animal fats and greases, vegetable oils, trace quantities of chlorine, dissolved hydrogen sulfide gas in concentrations up to 20 milligrams per liter, and oxygen may be either present or absent. During the normal life of these laminants, they will be exposed to the weather, including sunlight, both with and without liquid in the tank, and may be left in the dry condition for protracted periods. It is possible that dilute sulfuric acid may be present and may collect on any surface. Wastewater temperatures are expected to vary between 55 and 70 degrees Fahrenheit. The surface temperature of the weirs are expected to reach 120 degrees Fahrenheit when the tank is drained.

1.03 SUBMITTALS

A. The following shall be submitted for approval:

1. 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. 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 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.

2. Shop drawings showing equipment dimensions and materials of construction.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Materials used shall be per AWWA F102–96.

2.02 MANUFACTURE

A. DIMENSIONS:

1. The two weir plates shall be 72 inches wide by 12 inches high.

B. FABRICATION:

1. FRP weirs shall be fabricated by the matched–die molding process per AWWA F102–96. The final weir plate thickness shall be at least 1/4 inch. Slotted bolting holes shall be provided as shown to allow adjustment and leveling. Mounting shall permit expansion and contraction through the range of temperatures specified.

PART 3 – EXECUTION

3.01 EXECUTION

A. Field cutting of weir notches shall not be permitted. All field cuts required for installation shall receive two sealing coats.

B. Weirs shall be mounted, with gasket material, and leveled to a tolerance of plus or minus 0.01 foot during freshwater testing when the tank contains water to the normal operating level. Provisions shall be made to accommodate thermal expansion and contraction through the use of expansion joints at each weir plate joint.

END OF SECTION

INDEX TO

SECTION 40 40 01 – EQ. TANK JET MIXING EQUIPMENT

SECTION 40 40 01

EQ. JET MIXING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. The work includes providing equipment and field services, complete with accessories and appurtenances required for a Jet Mixing System that shall be installed within the flow equalization tank. A total of one (1) complete jet mixing system shall be provided in the tank measuring 114 ft diameter with a maximum SWD of 25'. Jet mixing system shall consist of all in–basin submerged liquid piping, in–basin submerged supports and externally mounted jet mixing pump with accessories. Control panel including motor starter shall be provided by others.

B. The Contractor shall coordinate the work specified in this section with the work of other sections in order that all necessary items shall be provided as required for satisfactory operation and that the various items of equipment will properly fit and operate in the spaces allotted to them.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 25 50 00 – Plant SCADA System

B. Division 26 – Electrical

1.3 SERVICE CONDITIONS

A. Service Conditions:

1.	Liquid Pumped:	Screened wastewater
2.	Temperature of water	15 degrees to 30 degrees C
3.	pH:	6 to 8
4.	Specific Gravity:	1.0

B. The Jet mixing equipment shall operate at constant speed and the control system shall be operated automatically through a PLC or timer–based control panel as well as manually through selection switches on the control panel face.

1.4 SUBMITTALS

A. Shop drawings and product data as described in Division 1.

B. Operation and maintenance data as described in Division 1.

C. In addition, submit the following:

Full equipment layout dimensional drawings and bill of materials, including:

1. Performance data curves showing head, capacity, horsepower demand, pump efficiency, and NPSH (required) over entire operating range of pump, from shutoff to maximum capacity.

2. Provide complete motor nameplate data, as defined by NEMA, motor manufacturer; and any motor modifications.

3. Detailed mixing calculations showing tank turnover, tank pumpage, mixing energy in BHP/MG of volume, mean velocity gradient, required water velocities and turn time.

4. Motor wiring diagram for the pump.

5. Complete operation and maintenance instructions for all equipment shall be submitted after the Shop Drawings are approved, but no more than thirty days after shipment of all equipment.

1.5 QUALITY ASSURANCE

A. Manufacturer: Fluidyne Corporation of Cedar Falls, IA or approved equal. The jet mixing system shall be a standard product of a manufacturer who has been actively providing jet mixing equipment including stainless steel mixing manifolds and pumps for a minimum of ten (10) years. The manufacturer shall have twenty (20) operating installations for a minimum of five (5) years utilizing stainless steel jet mixing manifolds with mixing pumps. References on mixing installations with details on the manufactured equipment shall be provided if requested.

1.6 WARRANTY

A. The system supplier shall provide a one (1) year warranty from the date of Substantial Project Completion in accordance with Division 1, not to exceed 18 months from date of complete shipment.

PART 2 PRODUCTS

2.1 JET MIXING SYSTEM:

A. The equipment furnished shall be a jet type mixing system. A total of two (2) jet mixing manifolds shall be provided in the basin. Each jet manifold shall include a minimum of twenty–two (22) jet mixing nozzles, configured in a uni–directional layout. The orifice size of each liquid nozzle shall be no less than 1.58 inches in diameter to avoid plugging problems. Layout of the jet mixing manifolds shall be as shown on the drawings. All nozzles shall be leveled and at same elevation (+/–) 1/4" by the contractor during installation. The mixing manifold shall be manufactured of 304 stainless steel for prolonged life. All materials must be resistant to a complete range of operating temperature, salinity, hardness, corrosiveness, and abrasives experienced in domestic wastewater treatment. The equipment must further be capable of continuous operation over extended periods. The mixing system shall be designed to provide mixing such that when operated under design conditions, it shall suspend materials found in equalization basin.

2.2 JET MIXING LIQUID MANIFOLD:

A. Jet mixing manifold shall be comprised of a liquid duct, mixing nozzles, mixing chambers with induction ports comprising one self–contained integrally formed unit. Sections shall ship in up to 20' length for field installation. The liquid duct shall be a circular, cylindrical tube having a plurality of liquid nozzles which are longitudinally spaced units, and which are aligned on a common plane. The liquid ducts shall be fabricated of corrosion resistant structurally sound material. Each multiple jet mixing assembly shall form a structural unit. All components of the manifold shall be constructed of 304 stainless steel.

2.3 JET NOZZLES

A. Nozzles shall have both an inner and outer assembly to facilitate mixing and increase tank turnover. All nozzles shall be fabricated out of 304 stainless steel. Nozzles shall come pre–welded to the jet manifold as shown in the Drawings.

2.4 JET MIXING PIPING:

A. All in basin submerged liquid piping shall be provided by the System Supplier as part of the system to the extent shown on the plans. All piping shall be 304 stainless steel schedule-10. Liquid piping shall be minimum 12" diameter and shall reduce down and terminate if and as necessary to terminate with a flange connection to mate to the discharge flange on the pump discharge elbow assembly. All interconnecting hardware and gaskets are to be included.

2.5 JET MIXING MANIFOLD HEADER SUPPORTS:

A. All necessary supports for the jet manifold shall be supplied as part of the system. The supports shall be manufactured of 304 stainless steel.

B. The supports shall be manufactured of 304 stainless steel. The supports shall consist of dual leg angle welded to a supporting base. The base shall be leveled and grouted in place if required. The support angles shall be field welded directly to the jet manifold by the contractor during installation with instructions to be supplied by the manufacturer.

2.6 PASSIVATION

A. All shop welded assemblies and components of the stainless-steel jet aeration manifold including manifold sections, piping and supports shall be completely passivated. Passivation of stainless-steel fabricated parts, piping, supports and assemblies shall conform to ASTM A380. Prior to passivation, all parts must be cleaned of any contaminants and generally must undergo a validating test to prove that the surface is clean. Once cleaned, the parts are then placed in an acidic passivating bath that meets the temperature and chemistry requirements of the Method and Type specified. Following the acidic passivating bath, the parts must then be neutralized using a bath of aqueous sodium hydroxide and then rinsed with clean water, dried, and the passive surface is validated using exposure to humidity, elevated temperature, a rusting agent, or some combination of the three.

2.7 MIXING PUMPS

A. Furnish one (1) installed vertical, closed coupled single stage jet mixing pump for each jet mixing manifold as an integral part of the jet mixing system. Pump shall be equipped with a **40 HP** premium efficient electric motor, connected for operation on 460 volts, 3 phase, 60 hertz electrical service. Pump motor shall be maximum 1200 RPM. The pump shall meet the following:

Service:	**Jet Aeration**
Model	12"– B5741CT
No. Of pumps:	**2**
Liquid:	Wastewater
Maximum Temperature (degree F):	80
Maximum speed (rpm):	885
Minimum shut–off head at max speed (ft):	41
Design capacity (gpm):	4400
Design total head (TH) (ft):	21
Minimum sphere solid size (in):	3.50
Minimum capacity at run out	4700 gpm
Minimum head at run out (ft):	18
Minimum efficiency at run out capacity:	72%
NPSHR at run out capacity (ft):	18
2nd design point capacity (gpm):	2500
2nd design point head (ft):	31
2nd design point efficiency (%);	73%
Motor HP	40
Minimum pump suction diameter (in):	14"
Minimum pump casing discharge diameter	12"

B. Major pump components shall be of grey cast iron, ASTM A–48. The pump shall have the base cast integrally with the front head. Suction flanges shall be 125 lb. ANSI drilled. Shall be provided with a combination base elbow of the Turbo free version, providing a low–profile setting. Conventional base elbows are not acceptable. Backhead shall be provided with an integrally cast sealing box.

Shaft Assembly

Minimum shaft diameter	**All Pumps**
1. At impeller	2.375"
2. At sleeve	2.625"
3. At thrust bearing	2.953"
4. At radial bearing	3.740"
5. Between bearings	4.00"
6. At Coupling	2.375"
7. Center to Center of bearings	14.125"

The pump shaft shall be high–strength alloy steel, A668 AISI 4140 HT; with a minimum 100,000 PSI tensile strength and 75,000 PSI yield strength of sufficient diameter to carry the maximum loads imposed and to prevent vibration and fatigue. The shaft shall be accurately machined along its entire length and precision ground at bearing locations. Keyways shall be provided at both ends.

Radial (inboard) bearings shall be grease lubricated double row spherical roller bearings designed to carry the hydraulic radial loads encountered in the service conditions. Thrust (outboard) bearings shall be an angular contact ball bearing designed to carry the pump hydraulic axial and dead load thrust. Bearing shall be designed for a nominal L10 life of 100,000 hrs. Per AFBMA at best efficiency point.

2.8 MECHANICAL SEALS

A. Each pump shall be provided with double mechanical seals with carbon vs. ceramic faces. The mechanical seals must be commercially available and manufactured by a major seal manufacturer, John Crane or equal.

2.9 PUMP SHAFT

A. The shaft shall be made from high quality steel, of sufficient diameter to carry the maximum load imposed and to prevent vibration and fatigue. Shaft is to be accurately machined along its entire length. A renewable shaft sleeve, positive adhesive sealed, shall protect the shat through the sealing box area.

2.10 IMPELLER

A. The impeller shall be a non–clogging type made of close–grained cast iron conforming to ASTM A48 Class 30. The impeller shall be of one–piece, single suction, enclosed two–vane, radial flow design with well–rounded leading vanes and then tapered toward the trailing edge for a circular flow pattern. The impeller is to be statically balanced and secured to a straight fit on the shaft by means of a bolt, washer and key.

2.11 VOLUTE/CASING

A. The volute is to be one–piece cast iron with side flanged tangential discharge. Discharge flange shall be 125 lb. ANSI drilling. Volute design to permit front or back impeller removal and be capable of radiation in increments to accommodate piping orientation independent of the base location. Casing shall be hydrostatically tested to 1.5 times the design head or 1.25 times the shutoff, whichever is greater.

2.12 MOTOR PROTECTION

A. Thermal overloads shall be installed in adjacent phases of the motor winding to provide overheat protection. These motor windings thermostats must be connected to an electric controller per local and state codes and the National Electric Code.

2.13 DESIGN CHARACTERISTICS

A. Design Characteristics

1. Fluid: Screened wastewater(2mm)–Max.0.5% solids
2. Temperature: 15 –32 degrees C
3. S.G.: 1.0
4. Pump Speed: 900 RPM maximum
5. HP Max: 40
6. Discharge: 12"

7. Solids Handling: 3"

2.14 CONTROL PANELS

A. To be provided by the General Contractor. (See Electrical Division)

2.15 INSTRUMENTATION

A. All instrumentation, wiring, cabling and conduit for all instrumentation and electrical motors shall be provided by the Contractor.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine stainless steel mixing headers and components to be sure that these are free from defects or damage.

B. Examine the pump to be sure all passages are clean and clear of obstruction and that the impeller rotates freely. Examine the pump mounting surface and make certain that bolts are properly located. Correct any irregularities prior to installation.

3.2 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the drawings. Installation shall include furnishing the required oil and grease for initial operation. See Section 01 77 00– Contract Closeout.

B. The Contractor shall submit a certification from the equipment manufacturer stating that the installation of the equipment is satisfactory, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit

3.3 SUPPLIERS / MANUFACTURERS' SERVICES

A. Field Service and Training: The Contractor shall provide the services of a factory–trained technician, employed by the jet mixing system supplier, with at least three years factory experience in jet mixing equipment. The factory technician shall be qualified to inspect installation, test for proper installation, conduct start–up, and train operators in the operation of the equipment and the process. A minimum of two (2) man days on the job site in a minimum of one (1) trip shall be provided.

END OF SECTION

INDEX TO

SECTION 40 80 01 – PROCESS PIPING LEAKAGE TESTING

SECTION 40 80 01

PROCESS PIPING LEAKAGE TESTING

PART 1 – GENERAL

1.01 SUBMITTALS

A. Information Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.

   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Test type.
   d. Method of isolation.
   e. Calculation of maximum allowable leakage for piping section(s).

2. Certifications of Calibration: Testing equipment.

3. Certified test report.

1.02 QUALITY ASSUERNCE

A. Testing shall be by a testing laboratory which operates in accordance to ASTM D 3740 or E 329 and shall be acceptable to Engineer prior to engagement. Mill certificates of tests on materials made by manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regular scheduled tests, spot checked by an outside laboratory, and furnishes satisfactory certificates with name of entity making test.

B. Infiltration, line and grade of sewer, pump performance; hydrostatic test on force mains and water mains and all other tests shall be made by the Contractor with equipment qualified by Engineer and in the presence of Engineer. Engineer or Project Representative reserves the right to accept or reject testing equipment.

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing five days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.

2. Wait seven days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to three days.

3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. New Piping Connected to Existing Piping:

a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.

b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

5. Items that so not require testing include tank overflows, and tank atmospheric vents.

6. Test Pressure: As indicated on in each section, and other sections (min. 150 psi)

C. Test section may be filled with water and allowed to stand under low pressure prior to testing. Contractor shall pretest prior to requesting an official test.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.

2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TESTING FOR PRESSURE PIPING

A. Fluids: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.

2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.

3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.

4. Maintain hydrostatic test pressure continuously for 120 minutes minimum, and for such additional time as necessary to conduct examinations for leakage.

5. Examine joints and connections for leakage.

6. Correct visible leakage and retest as specified.

7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.

2. Expel air from piping system during fill.

3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.

4. Maintain hydrostatic test pressure continuously for two hours minimum, reopening isolation valve only as necessary to restore test pressure.

5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

D. Hydrostatic and Leakage Tests – Ductile iron pipe shall be tested in accordance with AWWA Standard C 600, Section 5.2 – Hydrostatic Testing. Allowable leakage shall not exceed the formula $L = SDP^{1/2}/148{,}000$, in which L is allowable leakage in gallons per hour; S is length of pipe in feet tested; D is nominal diameter of pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

E. P.V.C. pipe shall be tested in accordance with AWWA Standard C 605, Section 7.3 – Hydrostatic Testing. Allowable leakage shall not exceed formula $Q = LDP^{1/2}/148{,}000$, in which Q is allowable leakage in gallons per hour; L is length of pipe in feet tested; D is nominal diameter of the pipe in inches; and P is average test pressure during leakage test in pounds per square inch gauge. Test shall be conducted for at least two hours and a pressure of 150 p.s.i. shall be maintained during the test. Fire lines shall be tested at 225 p.s.i. for the same duration.

1. Should any test of pipe laid disclose leakage greater than the above specified, Contractor shall, at its own expense, locate and repair defective joints until leakage is within specified allowance. Contractor is responsible for notifying the Engineer 48 hours (minimum) prior to applying pressure for testing. Pressure test will be witnessed by Engineer or Project

Representative. All visible leaks shall be repaired regardless of the leakage amount.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.

2. Piping larger than 18 inches.

3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.

2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.

3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase in steps of approximately one-tenth of specified test pressure until required test pressure is reached.

4. Maintain pneumatic test pressure continuously for minimum of ten minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visible evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 DEFLECTION FOR GRAVITY PIPING

A. It is the Contractor's responsibility to assure backfill is sufficient to limit pipe deflection to no more than five percent. When flexible pipe is used, a deflection test shall be made by Contractor on the entire length of installed pipeline, not less than 30–days after completion of all backfill and placement of any fill. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95 percent of the inside pipe diameter. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees Fahrenheit, and shall have a surface brinell hardness of not less than 150. The device shall be center bored and through bolted with a 1/4-inch minimum diameter steel shaft having a yield strength of 70,000 p.s.i. or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer; a pull exerted on opposite end of shaft shall produce compression throughout remote end of ball, cylinder, or circular section. Circular sections shall be spaced so distance from the external faces of front and back sections shall equal or exceed diameter of circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through by hand or by being flushed through with water, shall be cause for rejection of individual run. When a deflection device is used for the test in lieu of a ball, cylinder, or circular sections described, such device shall be acceptable to Engineer prior to use. Device shall be sensitive to 1.0 percent of diameter of pipe being measured and shall be accurate to 1.0 percent of indicated dimension. Installed pipe showing deflections greater than five percent of the normal diameter of pipe shall be retested by a run from opposite direction. If retest also fails, the suspect pipe shall be repaired or replaced at no cost to Owner. 100 percent of the pipe shall be tested.

3.05 LEAKAGE FOR GRAVITY PIPING

A. In no stretch of sewer between any two adjoining manholes shall infiltration/exfiltration exceed 25 gallons per day per inch of pipe diameter per mile of pipe. In case leakage exceeds this amount, the sewer shall not be accepted until such repairs and replacements are made to comply with above requirements. Such corrections will be made at the Contractor's expense. All visible leaks shall be repaired, regardless of the amount of leakage.

B. Lines shall be tested for leakage by low pressure air testing, infiltration tests, or exfiltration tests, as appropriate. Low pressure air testing for PVC pipe shall be as prescribed in ASTM F 1417. Prior to infiltration or exfiltration tests, trench shall be backfilled up to at least the lower half of pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When water table is two feet or more above top of pipe at upper end of pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to Engineer. When Engineer determines infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so a head of at least two feet is provided above both water table and top of pipe at upper end of pipeline to be tested. The filled line shall be allowed to stand until pipe has reached its maximum absorption, but not less than four hours. After absorption, the head shall be re–established. The amount of water required to maintain this water level during a two-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 25 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Owner.

C. The Contractor shall furnish equipment and plugs and subject force mains to hydrostatic tests at 100 p.s.i. for a period of two hours. Any leaks shall be located and repaired. Each section tested shall be slowly filled with water, care being taken to expel all air from the pipes. No pipe installation will be accepted until leakage during pressure test is less than the number of gallons listed for each 1000–feet of pipe tested:

6 inches & less – 0.9 gallons	12 inches – 1.80 gallons
8 inches – 1.20 gallons	14 inches – 2.10 gallons
10 inches – 1.50 gallons	16 inches – 2.40 gallons

100 percent of the pipe shall be tested.

3.06 DISINFECTION FOR WATER MAIN

A. After hydrostatic and leakage tests have been completed, water pipes shall be disinfected in accordance with AWWA C 651 and Regulations of the local Health Department.

B. All new mains shall be thoroughly flushed then chlorinated with not less than fifty parts per million (50 ppm) of available chlorine. Chlorine gas or 70 percent high–test calcium hypochlorite can be used. Water from existing distribution system or other source of supply should be controlled to flow slowly into the newly laid pipeline during application of chlorine. The solution shall be retained in pipeline for not less than 24 hours and a chlorine residual of 25 ppm shall be available at this time. Then system shall be flushed with potable water and the sampling program started. Prior to sampling, the chlorine residual must be reduced to normal system residual levels or be non–detectable in those systems not chlorinating. Normal system residual should be between 0.2 and 0.8 ppm. The chlorine residual shall be measured and reported. If the membrane filter method of analysis is used for coliform analysis, non–coliform growth must also be reported. If non–coliform growth is greater than eighty colonies per one hundred milliliters, the sample result is invalid and must be repeated.

C. A minimum of two samples from each sampling site shall be collected for total coliform analysis. The number of sites depends on amount of new construction, but must include all dead-end lines, be representative of water in newly constructed mains, and shall be collected a minimum of every 1,200 linear feet. Each set of samples shall be taken at least 24 hours apart after disinfection and tested by a State approved lab and shall indicate bacteriological satisfactory water. Contractor shall submit results to the Engineer.

3.07 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.

3. Test fluid.

4. Test pressure.

5. Remarks, including:

    a. Leaks (type, location).

    b. Repair/replacement performed to remedy excessive leakage.

6. Signed by Contractor and Engineer to represent that test has been satisfactory completed.

END OF SECTION

INDEX TO

SECTION 40 91 00 – PROCESS INSTRUMENTATION

SECTION 40 91 00

PROCESS INSTRUMENTATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor
25 50 00	Plant SCADA System

1.02 SCOPE

A. The Contractor shall furnish and install all instrumentation and instrumentation installation hardware, conduit, and wiring necessary to provide for the complete installation of all instrumentation described in this specification. At a minimum the Contractor shall be responsible for:

1. Purchasing of all instrumentation tagged on the P&ID drawings, instrumentation schedule, or others listed in these specifications.
2. Installation and termination of all instrument and power wiring.
3. Installation and connection of all instrument pneumatic tubing and related controls.
4. Performance of instrument calibration and loop checks.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports, or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

1.03 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:
   1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.
   2. A complete set of submittal information in PDF format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.04 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting & installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 – PRODUCTS

2.01 DISSOLVED OXYGEN SENSOR/TRANSMITTER

A. Sensor
   1. The sensor shall be a continuous-reading probe that utilizes luminescent sensor technology.
   2. All parts of the probe shall be corrosion resistant and fully-immersible.
   3. The measurement range shall be 0.00 to 20.00 mg/L dissolved oxygen.
   4. The operation of the analyzer shall not be affected by H2S, pH, K+1, Na+1, Mg+2, Ca+2, NH4+1, Al+3, Pb+2, Cd+2, Zn+2, Cr (total), Fe+2, Fe+3, Mn+2, Cu+2, Ni+2, Co+2, CN-1, NO3-1, SO4-2, S-2, PO4+3, Cl-1, anion active tensides, crude oils, or Cl2-1.
   5. The probe shall provide electrolyte-free operation without the requirements of sample conditioning.
   6. The sensor cap shall be warranted for one full year against defects in material and workmanship.

7. The probe shall be warranted for three full years against defects in material and workmanship.
8. Sensor shall be self-calibrating with a response time to 90% in less than 430 seconds or to 95% in less than 60 seconds at 20 degrees C.
9. Measurement accuracy shall be approximately.1ppm below 1 ppm and approximately .2 ppm above 1 ppm.
10. The sensor shall be approved for operation from 32 to 122 degrees F.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach LDO sensor with **SC200 controller.**
2. Approved equal.

2.02 TURBIDITY SENSOR/TRANSMITTER

A. Sensor
1. The turbidimeter shall be a microprocessor-based, continuous reading, on-line nephelometric instrument
2. The turbidimeter shall measure turbidity in the range of 0.001-100 NTU
3. Accuracy shall be approximately 2% of reading or approximately 0.015 NTU (whichever is greater) from 0 to 40 NTU; approximately 5% of reading from 40 to 100 NTU
4. Displayed resolution shall be 0.0001 NTU from 0 to 9.999 NTU and 0.001 NTU from 10.000 to 9.999 NTU.
5. Repeatability shall be better than approximately 1.0% of reading or approximately 0.002 NTU (whichever is greater).
6. The turbidimeter shall meet all design and performance criteria specified by USEPA method 180.1.
7. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample, eliminating glass windows and flow cells.
8. Optical components shall be mounted in a sealed head assembly that can be removed for calibration/ service without disturbing sample flow.
9. The turbidimeter body shall be corrosion-resistant.
10. An internal bubble removal system shall be included to vent entrained air from the sample stream.

11. Calibration of the turbidimeter shall be either formazin-based (20 or 1 NTU) or instrument comparison-based calibration method.
12. User selectable signal averaging, bubble removal, alarm and recorder output hold, and self-test diagnostics shall be provided.
13. Connections between the turbidimeter(s) and the controller shall be "plug and play."
14. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
15. The interface unit shall include two analog outputs and 3 unpowered SPDT alarm contacts.

B. Controller/Transmitter
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. Hach 1720E with SC200 controller.
2. Approved equal.

2.03 MIXED LIQUOR SUSPENDED SOLIDS (MLSS) SENSOR/TRANSMITTER

A. Sensor
1. The sensor shall use dual-beam infrared/scattered light photometer for measuring suspended solids. The LED shall transmit light at 45 degrees to the sensor face and the back-scatter photoreceptors shall detect scattered light at 140 degrees to the transmitted beam.
2. The sensor shall provide color-independent measurement.
3. The sensor shall be equipped with self-cleaning device to prevent erroneous values and maintenance problems.
4. The signal averaging time shall be user selectable ranging from 1 to 300 seconds.
5. The sensor shall be capable to measure from 0.001 mg/l to 50,000 mg/L.
6. Measurement accuracy shall be less than 5% of reading.
7. Measurement repeatability shall be less than 3% of reading.
8. The sensor shall be approved for operation from 32 F and 104 F.
9. The sensor shall be warranted for one full year.
10. The sensor shall be enclosed in stainless steel or PVC and shall include a silicon wiper blade and integral cable.

B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.
7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
1. HACH SOLITAX with SC200 controller.
2. Approved Equal.

2.04 pH SENSOR/TRANSMITTER

A. Sensor
1. The pH sensor shall be of differential electrode technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling resistant characteristics.
2. The pH sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 meters (328 feet) with standard cabling and up to 1000 meters (3280 feet) with a termination box.
3. The pH sensor shall have NTC 300 ohm thermistor for automatic temperature compensation and shall have a analyzer temperature readout.
4. The measurement range shall be -2 to 14 pH.
5. The measurement sensitivity shall be approximately 0.01pH.
6. The sensor shall be suitable for operation from 23 F to 158 F.
7. The sensor material shall be PEEK®, salt bridge of matching material with Kynar® junction, glass process electrode, titanium ground electrode, and Viton® O-ring seals.

B. Controller
1. The controller shall be a microprocessor-based instrument.
2. Connections between the sensors and the controller shall be "plug and play."
3. The Interface unit shall allow operators to control sensor and interface functions with menu-driven software.
4. The interface unit shall include two analog 4-20 mA outputs.
5. The interface unit shall be housed in a NEMA-4X/IP66 metal enclosure with corrosion-resistant finish.
6. The controller shall be capable of being mounted horizontally or vertically on a surface, panel, or pipe.

7. The AC power supply shall be housed in the interface unit and automatically accept input in the range of 100 to 230 VAC, 50/60 Hertz.
8. The controller shall be UL certified.
9. The controller shall be warranted for two full years against defects in material and workmanship.

C. Manufacturers
   1. HACH Differential pH with SC200 controller.
   2. Approved equal.

2.05 HYDROSTATIC LEVEL TRANSMITTER

A. The level transmitter shall be a hydrostatic pressure sensor with an integral baffle plate to protect the sensing element from debris.

B. The level transmitter shall measure up to 23 feet of water head.

C. The level transmitter shall have a static accuracy of 0.5% FSO BFSL and one-year stability of 0.20% FSO.

D. The response time shall be less than 5 ms.

E. The signal output shall be 4-20 mA DC two wire twisted pair grounded shield cable at 0.042 ohm per foot.

F. The transmitter shall be approved for operation from -20 F to 190 F.

G. The transmitter and sensor shall be made of 316 stainless steel. The cable shall be polyurethane-jacketed cable with 40 feet of length.

H. The transmitter shall require 10-30 VDC unregulated power.

I. Manufacturers
   1. Blue Ribbon Bird Cage Level Transmitter.
   2. Endress and Hauser FMX Level Transmitter.
   3. Approved equal.

2.06 ULTRASONIC LEVEL TRANMITTER

A. The transmitter shall use the Sonic Intelligence® echo processing technology.

B. The measuring range shall be 0.8 feet to 26 feet.

C. The accuracy shall be 0.25% of measuring range (in air).

D. The transmitter shall be suitable for operation under ambient temperature conditions from -40 F to 140 F and shall include built-in temperature compensation.

E. The Power supply required for the transmitter shall be 12 to 28 V DC, max 0.1 A. The max power consumption shall be 0.75 W (25 mA at 24 V DC).

F. The output signal shall be 4-20mA and max load shall be 600Ω in the loop at 24 V DC.

G. The transmitter shall have CE, CSA $_{NRTL/C}$, FM and 3A certificates, and approvals.

H. The transmitter electronics enclosure shall be made of PVC and transducer shall be made of PVDF copolymer.

I. Manufacturers
   1. Siemens Milltronics Level Transmitter.
   2. Approved equal.

2.07 LEVEL SWITCH

A. The level switch shall be an enclosed, narrow angle, mechanical float switch designed for use in sewage environments.

B. The level switch shall utilize mechanically-activate microswitches for indication of specific water levels. Level switches containing mercury shall not be acceptable.

C. The switches shall be a single-pole, double throw (SPDT) type and have an electrical rating of 10 amps at 120 VAC.

D. The power cord shall be chlorinated polyethylene type SJ00W-300 volt on 16/3.

E. The float shall be ABS or polypropylene material and shall be leak proof, shock proof, and impact resistant.

F. The level switches shall be supplied with an anchor to which the float shall be tethered. The anchor shall allow for adjustment of the actuation level and be of sufficient weight as to hold the floats secure in a well-mixed tank. The anchor shall be constructed of corrosion-resistant material suitable for continuous submergence in mixed liquor.

G. Manufacturers
   1. Conery 2902 Series Mechanical Angle float switches.
   2. Kobold NAE Series float switches.

2.08 TEMPERATURE SWITCH

A. The enclosure material shall be Die cast aluminum, epoxy powder coated, gasketed, and with captive cover screws.

B. The enclosure shall meet NEMA 4X requirements.

C. The set point repeatability shall be within approximately1% of adjustable temperature range.

D. The output shall be SPDT snap action switch.

E. The switch shall be electrically rated for 20A 125/250/480 VAC resistive.

F. The temperature dead band shall be within 2% of range under laboratory conditions (70 F ambient circulating bath at rate of ½ F per minute change).

G. The immersion stem shall be made of nickel-plated brass.

H. Manufacturers
   1. United Electric.
   2. Approved equal.

2.09 TEMPERATURE GAUGE

A. The temperature gauge shall be hermetically sealed to prevent moisture entry into the casing.

B. The temperature gauge shall be tamperproof with Maxivision dial for accurate temperature readings.

C. The temperature gauge shall be suitable for use in ambient temperature between -40 F and 200 F.

D. The temperature gauge shall measure temperature from 50 F to 400 F.

E. The temperature gauge accuracy shall be 1% full span to ASME B40.3 (Grade A).

F. The bimetal coils used are heat treated for optimum stability and over temperature capability.

G. The temperature gauge case and stem material shall be 304 SS.

H. Manufacturers
   1. Ashcroft Bimetal Thermometers.
   2. Approved equal.

2.10 FLOW SENSOR/TRANSMITTER FOR PERMEATE AND MIXED LIQUOR SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be ± 0.5% of rate ± 0.02% of full scale (33 feet per sec.) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from ½-inch to 78 inches.

E. The tube shall be lined with polyurethane and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges shall be ANSI B16.1 Class 150 for 12 inches and smaller and AWWA Class D for 14 inches and larger.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of 316SS material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16-character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
   1. Siemens Danfoss
   2. Endress Hauser Model 50P
   3. Approved equal.

2.11 FLOW SENSOR/TRANSMITTER FOR CLEAN-IN-PLACE CHEMICAL SERVICE

A. The flow meter shall be a magnetic flow meter which shall utilize bipolar pulse DC coil excitation to measure voltage induced by flow through a magnetic flux.

B. The voltage shall be linearly proportional to flow velocity from 0.033 to 33 feet per second. Standard accuracy of the pulse output between one and 33 feet per second shall be ± 0.5% of rate ± 0.02% of full scale (33 feet per see) for all meters.

C. The flow meters shall consist of a flanged metering tube and an integrally-mounted transmitter.

D. The flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 1 inch -12 inches.

E. The tube shall be lined with PTFE and shall have ISO standard flange to flange lay lengths. Unless noted otherwise in the instrument schedule, the flanges shall be ANSI B16.1 Class 150 for 12 inches.

F. There shall be two measuring electrodes, a grounding electrode, and one for empty pipe detection. The electrodes shall be the bullet-nosed type of Alloy C-22 material. The electrode circuit shall have a minimum impedance of 10^{12} ohms to overcome moderate coating buildup.

G. The transmitter shall be a three-stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC. Transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

H. A 2-line x 16-character backlight LCD shall simultaneously display flow rate and total flow in user-selectable engineering units. The display shall be used in conjunction with integral push buttons for configuration and diagnostic messages.

I. An integrated AUTO-ZERO function shall compensate for any external interference and eliminate zero-drift. An AUTOGAIN function shall enable a 1000:1 turndown measuring range by amplifying the measuring signal and increasing measurement resolution at various flow rates. To further ensure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation.

J. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

K. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

L. The meters shall be calibrated in a flow facility that is monitored by a globally acceptable monitoring agency such as NIST. Each meter shall ship with a certificate of a 3-point calibration report exceeding stated accuracy of 0.5%.

M. The manufacturer shall warranty the meters for manufacturing defects for a period of 18 months after shipment or 12 months after startup.

N. Manufacturers
   1. Siemens Danfoss

2. Approved equal

2.12 ROTAMETER (LIQUID SERVICE)

A. The liquid rotameter shall be a variable-area style flow meter.

B. The rotameter shall be rated for service up to 145 psig and temperatures up to 140-degree F with an accuracy of +/- 4% of full scale.

C. The rotameter shall have a polysulfone measuring tube with a direct reading scale which is calibrated for measurement in gallons per minute.

D. The rotameter shall be supplied with PVC socket x half union connections.

E. The float shall be PVDF.

F. The rotameter shall be supplied with EPDM o-rings.

G. Manufacturers
   1. Kobold KSM series
   2. Approved equal.

2.13 FLOW SENSOR/TRANSMITTER FOR AIR SERVICE

A. The flow meters shall be an insertion-style with an integrally-mounted transmitter.

B. The voltage shall be linearly proportional to flow velocity from 0.65 to 275 feet per second. Standard accuracy of the pulse output between .65 and 275 feet per second shall be +/- 1.5% of reading +/- 0.5% of full scale (275 Feet Per Second) for all meters. The installation location shall meet the manufactures installation guidelines for straight run requirements with and without using a flow conditioner.

C. The air flow metering system shall be microprocessor based and both the sensor and transmitter shall have chips to store and process data. The electronics shall be interchangeable for meters from 3 inches to 60 inches.

D. The metering mechanism shall be manufactured of 316 Stainless steel sensors shall be of the proper sizes to measure the design flow rate of the piping and shall be noted in the instrument schedule.

E. Repeatability 0.5% for velocities above 0.65 feet per second.

F. The transmitter shall be a three-stage microprocessor controller mounted integrally or remotely as specified in the instrument schedule. The power supply to the transmitter shall be 85 - 260 VAC, 45 to 65 Hertz. or 20 to 55 V AC, 45 to 65 Hertz, or 16 to 62 V DC transmitter housing shall be powder coated cast aluminum with NEMA 4X rating.

G. Upon any power failure, the unit shall retain all setup parameters and accumulated measurements internally in non-volatile memory. All units shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

H. The transmitter shall output a 4-20 mA DC directly proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output. The analog output shall have an adjustable response time from 0.06 to 100 seconds and shall include an infinitely adjustable low flow cutoff.

I. Each meter shall be provided with a certificate of a 3-point calibration report exceeding stated accuracy of 1.5% of reading for 100% to 20% of full scale at reference conditions, 0.3% of full scale for 20% to 1% of full scale at reference conditions.

J. Manufacturer
   1. Endress Hauser Model 65I.
   2. Sierra Model 640S.
   3. Approved equal.

2.14 ROTAMETER (AIR SERVICE)

A. The air flow rotameter shall be a glass tube variable-area style flow meter.

B. The rotameter shall be rated for service up to 100 psig and temperatures up to 212-degree F with an accuracy of +/- 1% of full scale.

C. The air flow rotameter shall have a tempered glass measuring tube with a direct reading scale which is calibrated for measurement of air in SCFH.

D. The rotameter shall be supplied with 316 stainless steel 150 lb ANSI flanges.

E. The float shall be 316 stainless steel

F. The rotameter shall be supplied with EPDM O-rings.

G. Manufacturers
   1. Kobold KDV series.
   2. Approved equal.

2.15 PRESSURE SENSOR/TRANSMITTER FOR LIQUID SERVICE

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero-point adjustment with no on-site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001 inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be +/- 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4...+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
   1. Endress+Hauser PMC131.
   2. Approved equal.

2.16 PRESSURE SENSOR/TRANMITTER (AIR SERVICE)

A. The pressure transmitter shall be a loop-powered, two-wire device requiring a 11-30 VDC power input with a 4-20 mA DC output, superimposed on the power input lines, proportional to the calibrated span. The sensor shall have a plus 5% zero-point adjustment with no on-site calibration required.

B. The transmitter shall be housed in a compact 304SS enclosure and shall be designed and constructed to allow for direct mechanical mounting by the process connection, requiring no additional mounting hardware. The enclosure shall be NEMA4X.

C. The transmitter shall utilize capacitance technology in conjunction with a dry cell (no oil fill) ceramic diaphragm design for pressures up to 500 PSIG/A. Maximum deflection of the ceramic diaphragm shall not exceed 0.001-inch full scale movement to minimize diaphragm fatigue and the effects of build-up. The ceramic diaphragm shall be immune to damage due to vacuum and shall have an overpressure (proof) pressure rating of at least 150 PSI.

D. The accuracy shall be +/- 0.5 % of full span including hysteresis and repeatability. The change of zero point between -4...+185 degrees F shall be no more than 1.5%. Long term stability shall not exceed a 0.15% shift per year.

E. Manufacturers
   1. Endress+Hauser PMC131.
   2. Approved equal.

2.17 PRESSURE SWITCH

A. The pressure switch shall feature diaphragm sensing technology, a 20-amp snap-acting switch, and adjustable pressure ranges up to 475 psi.

B. The pressure switch should be able to operate in 0 to 160 F (17 to 71 C). Set point shifts less than 1% of range for a 50 F (28 C) ambient temperature change.

C. The pressure switch shall use an EPDM sensor material and should handle a maximum temperature of 250 degrees F.

D. The pressure switch shall be enclosed in Type 1 Enclosure and shall be made of Zinc plated steel with bright chromate finish.

E. The pressure switch should be surface mounted with two screws through clearance holes or mounted by pressure connection.

F. The pressure switch shall have electrical rating of 20 A at 480 VAC

G. Manufacturers
   1. United electric 25 Series Model 25A1F4A pressure switch.
   2. Approved equal.

2.18 PRESSURE GAUGE

A. The pressure shall be solid front and hinged blow-out back style with elastomer compensating diaphragm on the inside of the hinged blow-out back.

B. The pressure gauge accuracy shall be 0.5% full scale to ASME B40.1 standard (Grade 2A)

C. The pressure gauge case and blow-out back shall be made of molded fiberglass reinforced thermoplastic and should be fire retardant and impact resistant

D. The pressure gauge lens shall be 4 mm thick laminated safety glass with lens rind made of molded fiberglass reinforced thermoplastic.

E. The fillable liquid used for the pressure gauge shall be glycerin.

F. The Stem and socket connections shall be made of 316 Stainless steel.

G. Manufacturers
   1. McDaniel MPB-S Pressure gauge.
   2. Approved equal.

PART 3 – EXECUTION

3.01 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner's Representative changes required to resolve interferences.

3.02 IDENTIFICATION PLATES AND CODING

A. All components provided under this section, both field and rack mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Rack mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.

B. The Contractor shall attach nametags to control devices with screws, bolts, or wire leader to create a permanent bond.

3.03 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.04 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.05 INSTRUMENT PROCESS CONNECTIONS

A. The Contractor shall complete all necessary connections to process equipment, control panels, and instruments as required to meet the intent of the drawings. All vents and drains from instrument process piping shall be routed to the proper vent headers or sewers as required for environmental reasons or as provided for in the job specifications and drawings.

B. Over range limit, maximum working pressure and static pressure limits shall not be exceeded to prevent damage to the transmitter. The Manufacturer shall specify all transmitters and measuring elements to be compatible with the pressure and temperature ranges of process parameters.

C. Process temperature limit, ambient temperature limit and storage temperature limit shall not be exceeded in any installation. The Manufacturer shall ensure the installation provides affordable protection to the instrument devices.

3.06 INSTRUMENT SETUP/PROGRAMMING

A. The contractor shall setup and program all instrumentation. As necessary, the Contractor shall have the Manufacturer's Representative on-site to program or setup any instrumentation and ensure that no warranties are voided.

B. Copies of all software, programs, or equipment setup logs shall be given to the Owner prior to completion of the project. This information shall be made available to the Owner or Owner's Representative upon request at any time during construction or check-out of equipment.

3.07 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.08 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.09 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 40 91 16.29 – MAGNETIC FLOW METERS

SECTION 40 91 16.29

MAGNETIC FLOW METERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall furnish, test, install and place in satisfactory operation the magnetic flow meters, with all hardware, conduit, wiring, spare parts, accessories, and appurtenances as herein specified, as recommended by the manufacturers and as shown on the Drawings necessary to complete installation.

B. The Contractor shall furnish and install all necessary items and appurtenances in addition to those shown on the drawings and specified for the proper operation of the instrumentation.

C. All instrument devices where applicable shall be connected to clean dry air and electrical supply systems. The system shall be continuity checked, leak tested, ground tested, calibrated, control valves stroked, all in-line devices bolted or mounted in the proper orientation and place in the process system as a complete operable system when released by the Contractor to the Owner.

D. Calibration standards shall be traceable to the National Institute of Standards and Technology. All instruments used to verify calibration shall have superior measurement capability and be of the highest quality and accuracy.

E. All work shall be constructed true to lines and surfaces indicated in a neat, substantial, and workmanlike manner and in such a way as to properly serve the purpose intended. Equipment shall be plumb and level. All members and parts, upon installation, shall be properly supported from the building structure, existing supports or independent support framing, secured together, and anchored in place.

F. In cases where detailed wiring or tubing information is not included within the drawings or the accompanying specifications, the Contractor shall be responsible for installation and connecting and placing the instrument devices into proper and satisfactory service. The manufacturers' technical publications shall serve as the guidelines to incorporate these devices into the design of the system.

G. Coordinate signal requirements with MBR System Supplier.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 40 91 00 Process Instrumentation

B. Section 45 50 00 Membrane Bioreactor (MBR) System

1.3 SUBMITTAL INFORMATION

A. In addition to any other requirements contained within the Contract Documents, provide the following:

1. Instrumentation schedule detailing tag numbers, drawing numbers, manufacturers, model numbers, process fluid, process connection type/size, line size, power requirements, and signal type.

2. A complete set of submittal information in PDF and MSWord format. All pertinent information needed to fully describe the instrumentation and accessories shall be included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

1.4 OPERATION & MAINTENANCE MANUALS

A. Operations & Maintenance manuals shall be provided prior to delivery of the instrumentation on site to support the installation of the instrumentation. The Operation & Maintenance manual in PDF form. Manuals shall include instrumentation dimensions, mounting and installation information, electrical connection information, calibration instructions, maintenance information, and a trouble shooting guide.

PART 2 - PRODUCTS

2.1 MAGNETIC FLOW METER SYSTEMS

A. Magnetic flow meter systems shall include a magnetic flow tube and a microprocessor-based "smart" transmitter that is capable of converting and transmitting a signal from the flow tube. Magnetic flow meters shall utilize the characterized field principle of electromagnetic induction and shall produce DC signals directly proportional to the liquid flow rate.

B. Each meter shall be furnished with a stainless-steel metering tube and carbon steel flanges with a polyurethane, ceramic, neoprene, or Teflon liner as required by the application and/or as specified herein. Liner shall have a minimum thickness of 0.125 inches. The inside diameter of the liner shall be within 0.125 inches of the inside diameter of the adjoining pipe. Liner protectors shall be provided on all flow tubes.

C. The flow tube shall be provided with flush mounted electrodes. Ultrasonic electrode cleaning shall not be acceptable.

D. Grounding rings shall be provided for all meters.

E. All materials of construction for metallic wetted parts (electrodes, grounding rings, etc.) shall be minimum 316 stainless steel, but shall be compatible with the process fluid for each meter in accordance with the recommendations of the manufacturer.

F. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of -30 to +65□C. Meter and transmitter housings shall meet NEMA 4X requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Non-metallic transmitter housings shall not be acceptable.

G. The transmitter shall provide pulsed DC coil drive current to the flow tube and shall convert the returning signal to a linear, isolated 4-20 mA DC signal. The transmitter shall utilize "smart" electronics and shall contain automatic, continuous zero correction, signal processing routines for noise rejection, and an integral LCD readout capable of displaying flow rate and totalized flow. The transmitter shall continuously run self-diagnostic routines and report errors via English language messages.

H. The transmitter's preamplifier input impedance shall be a minimum of 10^9-10^{11} ohms which shall make the system suited for the amplification of low-level input signals and capable of operation with a material build up on the electrodes.

I. The transmitter shall provide an automatic low flow cutoff below a user configurable low flow condition (0-10%). The transmitter's outputs shall also be capable of being forced to zero by an external contact operation.

J. Each flow tube shall be factory calibrated and assigned a calibration constant or factor to be entered into the associated transmitter as part of the meter configuration parameters. Manual calibration of the flow meter shall not be required. Meter configuration parameters shall be stored in non-volatile memory in the transmitter. An output hold feature shall be provided to maintain a constant output during configuration changes.

K. The transmitter shall be capable of communicating digitally with a remote configuration device via a frequency-shift-keyed, high frequency signal superimposed on the 4-20 mA output signal. The remote configuration device shall be capable of being placed anywhere in the 4-20 mA output loop. A password-based security lockout feature shall be provided to prevent unauthorized modification of configuration parameters.

L. Accuracy shall be 0.5 percent of rate over the flow velocity range of 1.0 to 30.0 feet per second. Repeatability shall be 0.1 percent of rate; minimum turndown shall be 100:1. Minimum required liquid conductivity shall not be greater than five uS/cm. Maximum response time shall be adjustable between 1 and 100 seconds as a minimum. Transmitter ambient temperature operating limits shall be -10 to +50°Celcius. Power supply shall be 115 VAC, 60 Hertzz.

M. Flow tubes shall be 150-pound flange mounted unless otherwise noted. The cables for interconnecting the meter and transmitter shall be furnished by the manufacturer. Transmitter shall be mounted integrally on flow tube, wall, or two-inch pipe mounted as shown in the Drawings or as specified.

N. Magnetic flow meter systems shall be as manufactured by **Siemens**.

PART 3 - EXECUTION

3.1 REQUIREMENTS

A. Ground magnetic flow meter flow tubes and grounding rings in strict accordance with the manufacturer's recommendations.

B. Refer to the specifications for further requirements.

3.2 GENERAL

A. All material and equipment shall be installed in accordance with manufacturer's technical instructions, engineering drawings and as may be required by the applicable codes of the state and city. Drawings do not attempt to show exact details of all routing, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this Contract that require offsets. Piping drawings shall be used as dimensioned and indicated for proper process taps to all instruments.

B. The Contractor shall be responsible for identifying interferences and submitting in writing to the Owner and Engineer changes required to resolve interferences.

3.3 WIRING INSTALLATION

A. Wiring shall be installed in a neat manner and exhibit no skinned insulation. Bends in cables and wiring shall not be less than manufacturers' recommended radius.

B. Connections at the instrument and terminal strips shall adhere to the strictest standards of quality terminations. Splices shall not be allowed except where instruments have pigtails. There the wire shall be scotch locked and taped to prevent moisture entering under the cap. High grade electrical tape shall be used. In all practical installation, terminations in junction boxes at terminal strips shall be provided.

3.4 INSTRUMENT INSTALLATION REQUIREMENTS

A. The Contractor shall install instrument devices in accordance with appropriate installation procedures to insure the manufacturers' published accuracy of the devices.

B. Extreme caution should be observed to install in-line measuring devices in the proper orientation. Manufacturer's installation procedures for placing the instrument in service shall be adhered to. Body ends and seats shall be installed facing the proper directions to insure no leakage occurs past the seat.

C. Gasket material as defined by the piping specifications shall be installed with the appropriate valves. Proper tightening of flange bolts to prevent uneven gasket loading shall be checked by the Contractor.

D. All instruments shall be installed in accordance with the location drawings and technical specifications guidelines. All instruments shall be accessible from grade, platforms, ladders or catwalks. All locally mounted indicating transmitters and gages shall be faced toward the normal operating aisle and be within reading capability from normal line of site.

E. Brackets shown for attachment to walls columns, masonry or structural steel shall be installed so as not to obstruct any access or regress from any approach.

F. Instruments shall be grouped where practical and be mounted in locations so as not to block motors or equipment required to be pulled for maintenance or check out.

G. Instruments shall be mounted level and plumb, rigidly supported in a manner disallowing transmission of vibration to adjoining structures, components, walls or cabinets. Freedom from interference of piping and electrical conduit shall be required. Services brought to the instruments shall not prevent the installation or removal for maintenance purposes. Process tubing routed to the instrument shall not block access to the instrument.

H. All instrument devices shall be calibrated, bench tested and verified ranges shall be recorded and checked against the specification sheet prior to installation in the field.

3.5 INSTRUMENT CALIBRATION

A. The Contractor shall calibrate all instrumentation in a suitable environment to quality testing procedures. High accuracy comparative instruments or mechanisms shall be the standard against which instrument calibration is tested.

B. Simulated operating conditions for individual instruments and operating as a complete loop or system shall be calibrated to ensure control accuracy.

C. Manufacturer's installation and calibration literature shall be kept in the same file and turned over to the owner at the end of commissioning the instruments.

D. Record keeping shall include all original calibration curves supplied and certified by the factory. Any additional maintenance literature shipped with the instrument shall be kept on record.

E. The Contractor shall not energize nor pressurize systems until the installations have been approved by the Owner.

3.6 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed instrumentation for visual deficiencies.

B. Prior to acceptance by owner, an operational test of all instruments and control systems shall be conducted to determine if the installed instruments meet the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.7 PROTECTION

A. The contractor shall be responsible for provisions to protect the instrumentation after installation but prior to acceptance by the Owner. Protection of the instrumentation shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 40 95 13 – MBR CONTROL PANEL

SECTION 40 95 13

MBR CONTROL PANEL

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.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following.

Section	Description
45 50 00	Membrane Bioreactor
40 95 20	MBR SCADA Hardware and Software

1.02 REFERENCES

A. Standards referenced in this section are listed below:

1. National Electrical Code (NEC): NFPA 70.

2. National Electrical Manufacturer's Association (NEMA):

   a. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volt Maximum).

   b. NEMA ICS 6 - Enclosures for Industrial Control and Systems.

3. Underwriters Laboratories Inc. (UL):

   a. UL 50 - Enclosures for Electrical Equipment.

   b. UL 508 - Industrial Control Equipment.

   c. UL 508A - Standard for Industrial Control Panels.

1.03 SCOPE

A. This Section specifies the hardware requirements for the MBR control panel.

B. The control panel, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 20 MBR SCADA Software and Hardware.

C. The control panel provider shall be responsible for the following:

A. Design of the MBR system control panel.

B. Development of the MBR system control panel submittal documentation and drawing set.

C. Fabrication of the MBR system control panel.

D. Delivery of the MBR system control panel in packaging designed to prevent physical damage.

1.04 QUALITY ASSURANCE

A. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by Underwriters Laboratories to assemble and certify UL-labeled control panels:

1. All components and equipment shall comply with requirements to meet UL508 listing.

2. All control panels shall be UL 508A labeled unless otherwise allowed for in the Contract Documents.

1.05 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified.

B. Submit the following control panel shop drawings in a single package:

1. Layout diagrams for all control panels and enclosures. Include panel elevations (front, side, interior), and sizing. Panel front elevations shall be of sufficient scale to allow all engraved nameplates and inscriptions to be legible without the use of schedules.

2. Wiring diagrams for all control panels. Diagrams shall be complete electrical wiring diagrams showing all components and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc. All wires and terminals shall be numbered on the diagrams, and line cross references shall be labeled. Include wiring interface to the SCADA controllers where applicable. Include on these drawings, a tag number to identify each component, referenced to a component identification list.

3. Power requirements and heat dissipation summary for all control panels. Power requirements shall state required voltages, currents, and phase(s). Heat dissipations shall be maximums and shall be given in Btu/hr. Summary shall be supplemented with calculations.

1.06 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the RFP and the Contract Documents. The warranty duration shall be 12 months beyond Final Acceptance. All hardware components that are part of the completed system shall be covered by the warranty. The control panel supplier shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 CABINET

A. Cabinets and panels with any dimension 36 inches or greater shall be provided with removable lifting lugs designed to facilitate safe moving and lifting of the panel during installation. All doors shall be fitted with common keyed locks.

B. Cabinets and panels located outdoors or in areas other than climate controlled (heated and air conditioned) electrical or control rooms, shall be as a minimum 316 stainless steel NEMA 4X construction. Cabinets located in chlorine storage/feed areas shall be of nonmetallic, FRP construction, rated NEMA 4X.

C. Cabinets and panels located indoors within climate controlled (heated and air-conditioned) electrical or control rooms shall be all steel fully enclosed NEMA 12 units with gasketed doors.

D. Cabinets and panels shall have doors on the front and shall be designed for front access. All cabinets shall be fitted with three-point door latches. Door latches for NEMA 4X cabinets shall be all stainless steel. Door hardware on NEMA 4X cabinets located in chlorine storage/feed areas shall be non-corrosive in that environment.

E. All cabinets and panels shall be provided with drawing pockets for as-built panel drawings. One copy of the appropriate panel as-built drawings shall be furnished and left in the pocket of each panel.

F. Cabinets and panels shall be prefabricated cabinets and panels by Hoffman, Rittal, Saginaw, or approved equal.

2.02 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Control and data acquisition associated with site equipment shall be performed by a Programmable Logic Controller (PLC).

B. Each PLC and I/O rack shall be equipped with its own regulated power supply module energized from a standard, commercial 120 VAC 60 Hz, single phase source provided by the Uninterruptible Power Supply. Any power transformation, rectification, regulation, or other conditioning necessary shall be provided as part of the unit's power supply package. The module shall have sufficient capability to handle the power requirements for all the PLC components and I/O points, including the required, installed spare I/O capacity.

C. The PLC shall be Allen-Bradley CompactLogix 1769-L32E or 1769-L35E. A minimum of 768 KB of user memory shall be installed. The actual amount of memory supplied shall be sufficient to provide 20% unused capacity when the entire PLC program, as provided, is loaded and running. Provide industrial Compact Flash module to maintain memory integrity of the PLC program and eliminate the need for downloading system programs from a host computer following temporary (short-term) power failures. PLC shall be capable of executing ladder logic, function blocks, structured text, and sequential flow chart logic.

D. All I/O modules shall be provided with screw-type terminal blocks with barriers between adjacent terminals for connection of field inputs. Terminals shall be suitable for accepting up to and including No. 14 AWG wire. All terminals shall be provided with unique identification. All I/O modules shall be Allen-Bradley 1769 series.

E. The PLC shall communicate with the MBR SCADA system over an Ethernet Modbus TCP/IP network.

F. I/O count shall be as required to implement the functional requirements of the system.

1. Size the I/O chassis for the required I/O cards plus the greater of 1 spare module or 10% additional spare I/O of each type.

2. If necessary, use expansion chassis to accommodate these requirements.

2.03 NETWORK SWITCHES AND MODEMS

A. As required to provide Owner with a complete and fully functional system.

2.04 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration.

B. Provide ten percent (rounded up) spare fuses (minimum of 10) of each type and rating supplied.

PART 3 - EXECUTION

3.01 FABRICATION

A. Enclosures shall provide mounting for power supplies, control equipment, input/output subsystems, panel-mounted equipment, and appurtenances. Ample space shall be provided between equipment to facilitate servicing and cooling.

B. Enclosures shall be sized to adequately dissipate heat generated by equipment mounted inside the panel. If required, one or more of the following shall be provided to facilitate cooling:

1. Louvered openings near the bottom and top.

2. Thermostatically controlled, low noise internal air blowers (initial set point 75 °F) to circulate air within the enclosure, maintaining a uniform internal temperature.

3. Thermostatically controlled, low-noise cooling fans to circulate outside air into the enclosure, exhausting through louvers near the top of the cabinet (NEMA 12 cabinets only). Air velocities through the enclosure shall be minimized to assure quiet operation.

4. All openings in cabinets and panels shall be fitted with dust filters.

C. Enclosures shall be constructed so that no screws or bolt heads are visible when viewed from the front. Punch cutouts for instruments and other devices shall be cut, punched, or drilled and smoothly finished with rounded edges.

D. Terminals shall be marked with a permanent, continuous marking strip. One side of each terminal shall be reserved exclusively for field incoming conductors. Common connections and jumpers required for internal wiring shall not be made on the field side of the terminal.

E. Wiring shall comply with accepted standard instrumentation and electrical practices. Power, control and signal wiring shall comply with Division 26 of the specifications.

F. Separate terminal strips shall be provided for each type of power and signal used within each cabinet.

G. All wiring shall be bundled and run open or enclosed in vented plastic wireway as required. Wireways shall be oversized by a minimum of 10%; overfilled wireways shall not be acceptable. All conductors run open shall be bundled and bound at regular intervals, not exceeding 12 inches, with nylon cable ties. Care shall be taken to separate electronic signal, discrete signal, and power wiring.

H. A copper 120 VAC ground bus shall be installed in each cabinet and shall be connected to the building power ground. A separate, isolated copper ground bus shall be installed in each cabinet for the logic (24 VDC) ground. Both ground buses shall be clearly labeled as to voltage and function.

I. All interior panel wiring shall be labeled and uniquely identified.

J. Enclosures shall be provided with a main circuit breaker and a circuit breaker on each individual branch circuit within and distributed from the panel. Main breaker and branch breaker sizes shall be coordinated such that an overload in a branch circuit will trip only the branch breaker but not the main breaker.

K. The power entrance to the panel shall be provided with a surge protection device.

L. The control panel shall be the source of power for all 120 VAC devices interconnected with the control panel including, but not limited to:

1. Solenoid valves

2. Electrically actuated valves

3. Instruments connected to the control panel.

M. Door mounted HOA switches shall be provided for all solenoid and non-modulating valves.

N. Fuse holders shall be indicating type.

O. A panel mounted UPS shall be included in each PLC cabinet. The UPS shall be sized to provide at least 30 minutes of run time for the PLC. The UPS shall also power any door mounted operator interface if included.

P. Intrinsic safety barriers shall be provided for all equipment signals originating in a hazardous area.

Q. Enclosures with any dimension larger than 36 inches shall be provided with fluorescent service lights and 120 VAC duplex receptacles for service equipment. Power to these devices shall be independent from the PLC power supply and its associated uninterruptible power system.

END OF SECTION

INDEX TO

SECTION 40 95 20 – MBR SCADA HARDWARE AND SOFTWARE

SECTION 40 95 20

MBR SCADA HARDWARE AND SOFTWARE

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.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor
40 95 13	MBR Control Panel

1.02 REFERENCES

A. Standards referenced in this section are listed below:

1. Underwriters Laboratories Inc. (UL)

1.03 DEFINITIONS

A. Operator Interface Terminal – A terminal usually embedded in a control panel that allows the operator to view and modify control system parameters. Operator Interface Terminals are not capable of running commercially available software.

B. Operator Workstation – A terminal that runs a commercially available operating system such as Windows. An Operator Station will usually execute the SCADA software. Operator Stations are usually desktop mounted personal computers. However, they may be computers that are designed to be embedded in the doors of control panels.

C. SCADA – Supervisory Control and Data Acquisition. A SCADA System is a computer (typically a personnel computer), or a group of computers and servers running a software dedicated for SCADA purposes. This SCADA software can exchange over industrial networks, with PLC's, VFD's, and other industrial devices. Typically, the SCADA software will allow for trending, graphic display, alarm tracking, and reporting of data.

D. SCADA System Provider – A company that takes a commercially available SCADA software package, and then develops a project specific application. This company will typically supply hardware for the SCADA software and application to operate on.

1.04 SCOPE

A. This Section specifies the SCADA software and hardware for control of the MBR system.

B. The SCADA system, as specified herein, shall be furnished by the same System Integrator as outlined in 40 95 13 MBR Control Panel.

C. The SCADA System Provider shall be responsible for the following:

1. Supply of the MBR system SCADA and Operator Workstation (the plant workstation).

2. Coordination with all panel suppliers to insure proper data transfer between the MBR operator station and control panels.

3. Delivery of Operator Workstation and SCADA software in packaging designed to prevent damage from static electricity and physical damage.

1.05 QUALITY ASSURANCE

A. All electrical components, devices, and accessories shall be UL listed.

1.06 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information shall fully describe the hardware, software, and accessories included in the submittal. Where multiple options are included within standard literature, project-specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals shall include, but not be limited to the following:

1. Hardware Product Information Submittal

2. Software Product Information Submittal

   a. Software License information shall be submitted for each software or program in the system, indicating the number of licenses provided for each type of program or software.

1.07 OPERATION AND MAINTENANCE MANUALS

A. The SCADA System Provider shall supply O&M manuals for all equipment and software provided. The manuals shall be developed for an electronic technician audience. A manual, or manuals, shall be furnished for all deliverable hardware, including OEM equipment. Manuals for OEM equipment shall contain original printed materials, not copies, and may be in the manufacturer's original format.

B. The SCADA System Provider shall supply a Graphical Interface Users' Manual. The manual shall be developed for an operations technician audience.

1. The Graphical Interface Users' Manual shall describe the configuration and functions of the provided Human Machine Interface. The manual shall describe in detail the operator interface operator interaction sequences. The following shall be provided, as a minimum:

a. Summary description of all major functions.

b. Presentation of data on displays.

c. Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.

d. Description of every message and alarm that the system is capable of outputting, and an explanation of what the message indicates.

C. O&M support materials shall include:

1. Program Media:

a. The SCADA System Provider shall furnish complete sets of program media documentation. These documents shall include source of all programs written by the SCADA System Provider specifically for the proposed system. This includes, SCADA applications, HMI scripting, and objects of all programs necessary for the operation and maintenance of the systems programs. If any changes are made to programs during commissioning, the SCADA System Provider shall provide, within 10 days, corrected copies of source, object, and system media.

2. Program Listings:

a. Each program listing shall include revision information. Each time a change is made in the listing, its revision level shall be documented by the party making the change. Program listings will include all in-program comments and documentation and must be clearly understandable by programmers familiar with the language used. Undocumented code is not acceptable.

3. Software Licenses:

a. Each software package shall be provided with documented serial numbers and verification of licenses in Owner's name.

4. Remote Access Procedure:

a. The Remote Access Procedure documentation shall describe configuration of remote access software including all applicable phone numbers, IP Addresses, usernames and passwords.

D. Final manuals and documentation shall be provided in an electronic format on media compatible with the optical drives supplied with system. Electronic documents shall be provided in both the native application used for creating the documents (MS Word, AutoCAD, etc.) and the Adobe PDF format.

1.08 WARRANTY

A. The system warranty shall consist of a full scope, in-place warranty, consistent with the provisions of the Terms and Conditions of the Agreement and this product manual. The warranty duration shall be 12 months beyond Final Acceptance. All software and hardware components that are part of the completed system shall be covered by the warranty. The SCADA System Provider shall coordinate any warranties provided by third party suppliers.

PART 2 - PRODUCTS

2.01 OPERATOR WORKSTATION

A. The requirements defined in this subsection apply to the computer-based components of the SCADA System Provider's proposed system.

1. All workstations shall be from a single manufacturer and be from the same "family" or product line. All computer equipment shall be from the equipment manufacturer's standard offering and shall not be specifically built nor require major modifications in order to meet the requirements set forth in this Specification.

2. The MBR SCADA system shall use an Ethernet network as the preferred peer-to-peer network.

B. Minimum Hardware Requirements:

1. Workstations shall be Dell Precision or equivalent with equal or higher quality. The minimum workstation hardware requirements are as follows:

a. 3.00 Ghz Intel® Xeon 4 processors w/2 MB Cache.

b. 2GB DDR3 SDRAM, ECC.

c. Dell 19-inch flat panel monitor.

d. 250 GB Hard Drive, SATA, 7200 RPM.

e. 16X DVD+/-RW Optical Drive.

f. Graphics card suitable to handle the graphics of the SCADA application.

g. Dell QuietKey keyboard.

h. Dell USB Optical Mouse.

2.02 UNINTERRUPTIBLE POWER SUPPLIES

A. Uninterruptible Power Supplies (UPS) will be provided for all workstations and network switches in the project. As a general rule, provide a dedicated UPS for each workstation. The UPS system shall be able to run on Utility or generator power without any disruption in service. The UPS shall also be able to absorb the transients generated by ATS changeover.

2.03 SCADA SOFTWARE

A. The requirements defined in this subsection apply to SCADA software and configuration of the proposed control system.

B. The SCADA software shall be capable of communicating to PLCs connected to the network, remote PLCs, I/O servers, and other devices on the network. The SCADA software shall have the following communications capabilities:

1. Diagnostic alarms shall be provided with the system that will automatically notify the operator of the failure of any communications path.

2. A package of communication drivers that shall include the following as a minimum:

a. Ethernet Modbus (TCP/IP).

b. Ethernet IP.

C. Security features shall be fully integrated to allow only users with appropriate security levels access to individual parts of the system. The SCADA software shall have the following:

1. Passwords hidden in both the configuration and runtime environments to ensure that other personnel cannot access another account.

2. Monitoring and logging of each control action of each user. This shall include all operator control actions, including system log-in and log-out. The sequence of actions shall be viewable within the SCADA package and also exported to an external open file format (e.g. txt, csv) for later analysis.

3. Automatically log out a user after an adjustable time period. Logging out a user will only cause the system shall revert to a view-only security status. Logging out will not shutdown the system.

4. A minimum of four privilege levels. The software shall ensure that a user has access to all tasks for his privilege level. If the user does not have the correct privilege for a task, a message will indicate insufficient privilege.

5. Assign each graphic object to a plant area, define the privilege level, define whether operator input is enabled or disabled, and if the object will be interactive or not based on the operator's current privilege levels within the plant area.

D. The SCADA software shall have the following graphical display features:

1. Capable of displaying images from 3rd party packages for use within the SCADA displays.

2. Capable of pop-up windows for trends, loops, device status, and device control by clicking on hot spots or objects on the main graphics page.

3. Ability to allow the user to navigate around the graphics system utilizing a variety of navigation methods.

4. Hot Key links to specific graphics pages from the keyboard.

5. Navigation menus allowing access to system set-points, trends, logs, and performance summary pages from any page.

6. Configured with "hot spots," where as a user can click on the area and drill down into a detailed view (if available) of the plant area.

E. The SCADA software shall monitor and display all analog, discrete, and calculated process values.

1. Historical data logging functionality shall be provided:

a. All analog and calculated values shall be logged to a local database with value, time and date labels.

b. Data logged to disk shall be viewable while the system is online or offline without interrupting data collection.

c. Ability to export historical data logs to an external open file format (e.g. txt, csv) for later analysis shall be provided.

F. The SCADA software shall monitor and display all process alarm conditions.

1. Alarm display shall have the following:

a. Alarms shall be configurable in multiple levels. The color of the text of the alarm message shall indicate priority. Text color shall be configurable by engineers.

b. Provided with a standard alarm display page. The alarm page shall allow for scrolling of alarms, and acknowledgment of individual alarms or all alarms on the page.

c. Possibility to display the following information for each alarm as it appears on an alarm display page:

i. Alarm Tag Name.

ii. Alarm Description.

iii. Value of the Variable.

iv. Trip point.

v. Alarm Status: Disabled, Acknowledged, Unacknowledged.

vi. Alarm Category or Priority.

vii. Time & Date.

viii. Category.

d. A mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date /time range, state or type.

2. Alarm logging functionality shall be provided:

a. The alarms shall be able to be logged to a local database with alarm text, time and date labels.

b. Alarms that are logged to disk shall be viewable while the system is online or offline without interrupting data collection.

c. Ability to export alarm logs to an external open file format (e.g. txt, csv) for later analysis shall be provided.

G. The software shall provide the following trending functionality.

1. The software shall be capable of displaying historical trend information over a user configurable time period.

2. Every analog tag defined in the system configuration shall be available for trending.

3. The software shall have the following in its native functionality:

a. Line graphs with time on a linear, continuous horizontal or vertical axis and the trended variable on the vertical or horizontal axis.

b. Where more than one variable is displayed on the same graph, the pen color of each variable and associated information shall be displayed in a different color.

c. Each trend graph shall be capable of displaying a minimum of eight trend pens.

d. Each pen shall display individual ranges and engineering units. Each pen shall be scalable for display purposes independent to each other pen displayed on a page.

e. Include the capability to pan backward and forward within a selected time range to read the exact value of any displayed variable, by selecting a point on the graph or chart. The system shall display historical information as far back in time as desired.

f. The trend display shall be dynamic, scrolling through time, with the capability to stop the automatic scrolling of the trend for detailed analysis of a point in history.

g. The trend display shall have a minimum of two slide wires that can be moved over the page. The slide wires will provide indication of the date, time, and value at the intersection of the slide wire and the trend point.

h. The software shall provide "zoom" and "pan" facilities for both the trended variable range and the time axis range.

i. The software shall make available trending data from the historical database for export to disk files or external databases. Data shall be exported to csv or txt formatted files.

H. SCADA software shall be Wonderware Intouch.

2.04 OPERATOR WORKSTATION SOFTWARE

A. The MBR Operator Workstation software package shall support dual core and multi-processor CPU's.

B. As a minimum, the SCADA software shall run development and runtime implementations on the following Microsoft operating systems:

1. Windows 7 Professional.

C. The specified SCADA functionality shall have communications drivers, graphics capabilities, data reporting, historical storage, trend and alarm displays, and the development environment offered as a single integrated software package or suite of packages. Additionally, software will be supplied to enhance functionality of the software package:

1. Word Processing and Spreadsheets: Microsoft Office 2007 Basic.

2.05 MISCELLANEOUS REQUIREMENTS

A. All material shall be new, unused and actively marketed for new applications when shipped for configuration. All acquired hardware and software shall be registered to "The Owner," as user, and "Owner's Company's Name," as the organization.

B. Provide "mock-up" of screen views to Engineer for approval.

END OF SECTION

INDEX TO

SECTION 41 22 13 – OVERHEAD CRANES AND HOISTS

SECTION 41 22 13

OVERHEAD CRANES AND HOISTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions (if included), and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

A. Monorail and Hoist

1. Unless otherwise noted, this section includes furnishing and installing the overhead hoisting equipment, controls, trolleys and supporting monorails in accordance with the drawings and specifications for the operation shown on the drawings and specified herein.
2. All work performed under this section shall comply and be in accordance with trade approved practices and manufacturer's recommendations, including Safety Standards ASME / ANSI B30.16 "Overhead Hoists (Underhung)".

1.3 QUALITY ASSURANCE

A. Standards - The overhead electric chain hoists shall conform to the following standards:
1. Hoist Manufacturer's Institute (HMI)
2. American National Standards Institute (ANSI)
3. National Electrical Code (NEC)
4. American Society of Mechanical Engineers (ASME)
5. Comply with CSA Standards (when necessary to do so)
6. Lifetime warranty against defective material and workmanship

1.4 SUBMITTALS

A. In accordance with Division 1, submit the following:
1. Manufacturer's Literature: Submit cut sheets and all necessary information to enable evaluation of product quality and performance and fulfillment of the requirements herein.
2. Complete list of equipment with the manufacturer's name and model numbers.
3. Shop drawings of crane, runway beam, rails, and associated supports.
4. Crane cross-section sketches with all pertinent dimensions.
5. Design loads.
6. Manufacturer's painting and galvanizing system for cranes and monorails.

1.5 OPERATING SPECIFICATIONS

Capacity:	**3.5- tons**
Duty Class:	CMAA Class C
Span: Runway Length	44 ft.+/- 99'-4"
Steel:	AISC Hot Rolled Shapes or Plate
Bridge Girder Deflection:	L/600
End Trucks:	Dual drive with rotating axles. Motors shall include AC magnetic disc brakes per CMAA requirements.
Hoist: Lift:	**3.5 Ton**, Electric S.S. wire rope hoist 40'-0"
Trolley:	Motor driven with drive wheels each side and AC magnetic brakes per CMAA requirements.
Speeds:	Bridge 100 *fpm* adjustable to max Trolley 65 fpm adjustable to max Hoist 19 and 3.3fpm
Speed Controls	Bridge: ___ 2speed VFD ___Stepless VFD Trolley ___ 2speed VFD ___Stepless VFD Hoist (s) ___ 2speed Magnetic ___2speed VFD ____Stepless Vector VFD
Voltage:	460 V 3 Ph 60 Hz, 115-volt control.
Environment:	Outdoor, under cover
Bumpers:	Rubber bumpers on end trucks and trolley per CMAA requirements.
Limit Switches	Hoist with geared upper and lower limit switch and block operated upper limit, overload limit switch set at 115% of full load. Trolley and bridge with travel limit switches.

1.6 QUALITY ASSURANCE

A. Manufacturers shall have documented experience for ten (10) years, having successfully designed and built installations of similar scope.

B. Manufacturer shall be responsible for providing equipment of highest quality and workmanship that will perform specific functions reliably and safely.

1.7 DELIVERY, STORAGE AND HANDLING

A. Unloading and storage of crane shall be under the direct supervision of manufacturer.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. All major components shall be provided by **Konecranes, Inc.**

B. Hoists, trolleys, bridge end trucks, drives and controls shall all be from one suppler and shall meet the requirements of this specification:

2.02 RUNWAY ELECTRIFICATION

A. The runway conductors shall be Figure-8, rolled stainless steel bar as supplied by Duct-o-wire Corporation. The minimum capacity of the conductor bar shall be sized to carry the necessary ampere load without undue heating.

B. A four-conductor configuration shall be provided with all brackets, hangers, splice covers, power feeds, expansion gap assemblies and collectors as required by Conductix, Insul8 or Duct-o-wire.

2.03 RUNWAY BEAMS AND RAILS

A. Runway beams shall be designed by a Registered Professional Engineer to meet the requirements of AISC and shall be supplied by the crane manufacturer.

B. Rails shall be ASCE rails, sized according to the crane wheel loads and shall be supplied by the crane manufacturer.

C. The runway rails shall be attached to the runway beams using hook bolts, rail clips or clamps, as determined by the crane manufacturer.

2.4 ELECTRICAL EQUIPMENT AND POWER SUPPLY

A. Power supply for the hoist shall be 460-volt, 3 ph., 60 Hz. All power required for the operation of the hoist, trolley, and end trucks shall be developed from this source.

B. Runway electrification shall be 4-bar safety type rigid conductors as manufactured by Insul-8, Duct-O-Wire Company or Wampfler. Wall mounted disconnect switch and power to runway conductors provided by Electrical Contractor.

C. Cross bridge electrification shall be flat cable style festoon system with terminal box, multi-conductor cord, plug connectors (when available) and accessories. Cables are to be hardwired when plug connectors are not available.

D. Controls

1. Six-way operation, plug-in pushbutton pendant suspended from independent festoon track. Radio control may be included as an option.

2. Pendant shall include Start (momentary) button, Emergency Stop (push to maintain-turn to release) that controls a mainline contactor in the bridge panel.

1. Pushbutton shall be clearly marked with hoist, trolley and bridge travel directions.

2. Hoist shall be 2 speed magnetic reversing type (standard) or variable frequency inverter control (optional) and the trolley and bridge controls shall be variable frequency inverter control (standard), as required per section 1.01.B.

3. Electrical control enclosures shall be IP55 or NEMA 4 type. Pushbutton enclosure shall be non-corrosive, non-conductive and have a rating of IP65, NEMA 4X, 4 or 5.

2.5 EQUIPMENT

A. HOIST & TROLLEYS

1. Under-running single girder crane shall utilize the CXT low head room trolley hoist as manufactured by Konecranes, Inc.

2. The hoist shall be equipped with an electro-mechanical load-limiting device that shall prevent lifting more than 115% of the rated load.

3. Hoist and trolley motors shall be per 1.01B above, as applicable.

4. Hoisting motor(s) shall be two-speed/two winding squirrel cage type with a speed ratio of 6:1.

5. Hoisting motor(s) shall be totally enclosed with IP55 protection, minimum class F insulation, Klixon type bimetal switch for thermal protection and shall have a 60% ED rating.

6. Trolley shall be furnished with an adjustable frequency inverter drive and two-step or infinitely variable speed control for smooth acceleration and deceleration.

7. Trolley motors shall be inverter duty motors with minimum class "F" insulation and motor enclosures shall be TENV [totally enclosed non-ventilated].

8. Rotary cam type limit switch equipped with 4 micro-switches shall be

provided. Limit switch shall provide upper and lower limit of hoist travel, hoist slow down prior to reaching upper limit and phase sequence supervision at upper limit.

9. Hoist motor brake shall be DC disc type with adequate torque to stop and hold over 125% of the hoist rated load.

10. Large diameter rope drum with minimum of 36:1 drum to wire rope diameter ration. Groove depth shall be at least 35% of rope diameter. The rope drum shall be equipped with a rope guide to help keep the rope aligned in the grooves of the drum.

11. Wire rope shall be constructed from Stainless Steel having a minimum safety factor of 5.

12. Hoist reeving shall be single reeved. Lateral hook drift shall not exceed 1/8 inch per foot of vertical travel on single reeved models.

13. The hoist nameplate is to carry a CSA c/us rating. The actual hoist control enclosure rating shall be at least equivalent to IP55 / NEMA 4 type.

14. Hooks shall be made of forged alloy steel (34CrMo4QT or 34CrNiMo6QT) and shall be fitted with a spring-loaded flipper-type safety latch.

15. Hoist shall have a duty rating suitable for the load class and load cycles of the application (reference appendix A).

16. AGMA quality class 12 machine cut, hardened and precision ground hoist gearing. The gears inside the hoist gearboxes on models up to 5-ton capacity are lubricated by semi-fluid grease. On models over 5-ton capacity the gears inside the hoist gearbox are lubricated with semi-fluid grease or oil.

17. AGMA quality class 10, hardened and precision ground trolley drive gearing, lubricated by semi-fluid grease.

18. Trolleys shall have safety drop lugs and energy absorbing bumpers.

B. Bridge Girder

1. Bridge girder shall be per 1.01B above, as applicable.

2. Bridge girders shall be constructed from welded box girders or Structural beams, Steel, ASTM A36 , A50 or A992, as required.

C. End Trucks and Bridge Drive

1. End trucks shall be designed in accordance with CMAA specification as applicable for the type crane.

2. End trucks shall be bolted (not welded) to bridge girder.

3. Bridge drive shall be dual motor (A–4 arrangement per CMAA).

4. Bridge drive shall be designed to stop bridge within CMAA specifications.

5. End trucks shall be equipped with rail sweeps and energy–absorbing rubber bumpers.

6. Travel limit switches to be provided as necessary for safe operation.

7. Bridge shall be furnished with an adjustable frequency inverter drive and two–step or infinitely variable speed control for smooth acceleration and deceleration.

8. Bridge motors shall be inverter duty motors with minimum class "F" insulation and motor enclosures shall be TENV (totally enclosed non–ventilated).

9. AGMA quality class 10, hardened and precision ground bridge drive gearing, lubricated by semifluid grease.

10. Bridge girder shall be per 1.01B above, as applicable.

11. Bridge girders shall be constructed from welded box girders or Structural beams, Steel, ASTM A36 A50 or A992, as required.

PART 3 – EXECUTION

3.1 INSTALLATION

A. The Contractor shall review the dimensions of the crane and hoist shop drawing submittals as well as the basin & roof shop drawings to ensure that the crane assembly fits properly within the specified location and that there are no operating interferences.

B. The Contractor shall install runway beams, rails, bridge crane, hoist, controls, and accessories as the building is being constructed. Mount crane plumb and square with surrounding structure.

C. Immediately after runway beams are installed, Hoist Supplier shall survey runway beams to ensure that erection tolerances meet requirements of the CMAA Specification Number 70. If adjustments are necessary, the Contractor shall re-position runway beams to ensure smooth operation of crane.

D. After crane system is installed, Hoist Supplier shall inspect the crane and perform start-up operations.

1. Hoist supplier shall survey the runway beams and ASCE rails immediately after installation and perform start-up operations after full system is

installed.

E. Upon completion and before final acceptance, each hoist system shall be tested by an OSHA certified crane inspector per the State of Georgia OSHA requirements. Written documentation of the tests shall be given to the Owner. Tests shall include, but are not limited to the following:

1. Load test of 125% of rated capacity for critical positions along the full travel of the crane and hoist. Crane Supplier shall provide test weights.

2. Hoisting and lowering.

3. Trolley travel.

4. Locking and safety devices.

END OF SECTION

INDEX TO

SECTION 43 21 21 – SELF-PRIMING PUMPS

SECTION 43 21 21

SELF PRIMING PUMPS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of self priming pump(s) described in this Specification.

B. Pump(s) shall be designed for continuous duty operation, to provide the transfer of fluid volumes as defined in the Pump Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. The manufacturer of the pump shall have a quality management system in place and shall be ISO 9001 certified.

B. The pump and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the pump(s) and associated accessories.

C. The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufactured who has been actively engaged in the supply of similarly sized pumps for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the manufacturer's recommendations and the Contract Documents.

1.04 SUBMITTAL INFORMATION

A. Provide a complete sets of submittal information in PDF format. All pertinent information needed to fully describe the pump(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer
2. Type and Model
3. Rotational speed
4. Major component materials of construction
5. Pump specification describing construction details
6. Outline Dimension Drawing
7. Installation Drawing
8. Complete performance data showing capacity and power input
9. Electrical Data that includes
    a. Motor rating, hp
    b. Motor temperature rating
    c. Motor full load rotational speed
    d. Motor full load current
    e. Motor locked rotor current
10. Motor performance curves showing speed, efficiency, current, power, etc.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include pump outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS

A. Provide the following spare parts to the Owner, boxed, marked, and ready for long-term storage:

1. One set of mechanical seal assemblies for each size pump.

2. One complete set of gaskets for each size pump.

PART 2 – PRODUCTS

2.01 PUMP DESIGN

A. Pumps must be designed to handle raw, screened, industrial waste.

B. Solids Handling Capability – When pumps are used for handling raw wastewater or activated sludge, all internal passages, impeller vanes, and recirculation ports shall pass a 2.5" spherical solid. Smaller internal passages that create a maintenance nuisance or interfere with priming and pump performance shall not be permitted. Upon request from the engineer or owner, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.

C. Reprime Performance:

1. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.

2. Pump must reprime the Maximum Repriming Lift shown in the Pump Schedule at the specified speed and impeller diameter while operating with only one-half of the liquid remaining in the pump casing. (Reprime lift is defined as the static height of the pump suction above the liquid.)

3. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition.

4. Upon request from the engineer or owner, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

D. Pumps shall be end suction, single stage, horizontal frame mounted, vertical V-belt type base, self-priming centrifugal type.

E. Materials and Construction Features

1. Pump casing: Casing shall be cast iron Class 30 with integral volute scroll. Casing shall incorporate following features:

a. Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

b. Fill port cover plate, 3 1/2" diameter, shall be opened after loosening a hand nut/clamp bar assembly. In consideration for safety, hand nut threads must provide slow release of pressure, and the clamp bar shall be retained by detente lugs. A Teflon gasket shall prevent adhesion of the fill port cover to the casing.

c. Casing drain plug shall be at least 1 1/4" NPT to insure complete and rapid draining.

2. Cover plate: Cover plate shall be cast iron Class 30. Design must incorporate following maintenance features:

a. Retained by hand nuts for complete access to pump interior. Cover plate removal must provide ample clearance for removal of stoppages, and allow service to the impeller, seal, wearplate or check valve without removing suction or discharge piping.

b. A replaceable wear plate secured to the cover plate by weld studs and nuts shall be AISI 1015 HRS.

c. In consideration for safety, a pressure relief valve shall be supplied in the coverplate. Relief valve shall open at 75-200 PSI.

d. Two O-rings of Buna-N material shall seal coverplate to pump casing.

e. Pusher bolt capability to assist in removal of coverplate. Pusher bolt threaded holes shall be sized to accept same retaining capscrews as used in rotating assembly.

f. Easy-grip handle shall be mounted to face of coverplate.

3. Rotating Assembly: A rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, sealplate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

a. Sealplate and bearing housing shall be cast iron Class 30. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped. Three lip seals will prevent leakage of oil.

i The bearing cavity shall have an oil level sight gauge and fill plug check valve. The clear sight gauge shall provide easy monitoring of the bearing cavity oil level and condition of oil without removal of the fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

ii The seal cavity shall have an oil level sight gauge and fill/vent plug. The clear sight gauge shall provide easy monitoring of the seal cavity oil level and condition of oil without removal of the fill/vent plug.

iii Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.

b. Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.

c. Shaft shall be AISI 4140 alloy steel unless otherwise specified by the engineer or owner, in which case AISI 17-4 pH stainless steel shall be supplied.

d. Bearings shall be anti-friction ball type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir. Pump designs which use the same oil to lubricate the bearings and shaft seal shall not be acceptable.

e. Shaft seal shall be oil lubricated mechanical type. The stationary and rotating seal faces shall be silicon carbide alloy. Each mating surface shall be lapped to within three light bands flatness (35 millionths of an inch), as measured by an optical flat under monochromatic light. The stationary seal seat shall be double floating by virtue of a dual O-ring design; an external O-ring secures the stationary seat to the sealplate, and an internal O-ring holds the faces in alignment during periods of mechanical or hydraulic shock (loads which cause shaft deflection, vibration, and axial/radial movement). Elastomers shall be viton. Cage and spring to be AISI 316 stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings.

f. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same capscrews as used for retaining rotating assembly.

4. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.

a. Clearances shall be maintained by external shimless coverplate adjustment, utilizing collar and adjusting screw design for incremental adjustment of clearances by hand. Requirement of realignment of belts, couplings, etc., shall not be acceptable. Coverplate shall be capable of being removed without disturbing clearance settings.

b. There shall be provisions for additional clearance adjustment in the event that adjustment tolerances have been depleted from the coverplate side of the pump. The removal of stainless steel shims from the rotating assembly side of the pump shall allow for further adjustment as described above.

c. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.

5. Suction check valve shall be molded Neoprene with integral steel and nylon reinforcement. A blow-out center shall protect pump casing from hydraulic shock or excessive pressure. Removal or installation of the check valve must be accomplished through the coverplate opening, without disturbing the suction piping. Sole function of check valve shall be to save energy by eliminating need to reprime after each pumping cycle. Pumps requiring a suction check valve to assist reprime will not be acceptable.

6. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports and meeting ANSI B16.1,Class 125. Each spool shall have one 1-1/4" NPT and one 1/4" NPT tapped hole with pipe plugs for mounting gauges or other equipment.

F. Motor

1. Motors shall be squirrel cage induction type, totally enclosed, fan cooled, rated for inverter duty (unless otherwise stated).

2. Motors shall be 460 volts, 60 Hz, 3 phase.

3. Motors shall have NEMA Class F insulation.

4. Motor performance shall conform to the requirements of NEMA MG1 Part 12 and shall be expressed as indicated in NEMA MG1-12.30.

5. Motors shall have a 1.15 service factor rating. The pump brake horsepower requirements shall not exceed the motor name plate horsepower under the operating conditions listed in the Pump Schedule.

6. Motors shall be premium efficiency type.

7. Inverter Duty:

a. All motors indicated in the Pump Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

ii Inverter grade, 1,600 volt, Class F insulation.

iii Service factor of 1.0 when operated from a VFD.

iv Meeting requirements of NEMA MG1 Part 31.

G. Hazardous Location Equipment

1. In addition to the requirements listed above, for the installations which are considered to be in hazardous locations as defined by the National Electrical Code (NEC), only motors certified by Factory Mutual for use in such locations shall be used.

2. Specifically, the pump motors used shall be certified for use in all Class I, Divisions 1 and 2, Groups C and D, Class II, Divisions 1 and 2, Groups E, and G and Class III locations as outlined in Articles 500-502 inclusive of the NEC code.

H. Manufacturer's Warranty:

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. All equipment, apparatus, and parts furnished shall be warranted for five (5) years, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified by the engineer or owner, or as represented by the manufacturer, or as proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the owner.

4. The warranty shall become effective sixty (60) days after installation, or ninety (90) days after shipment, whichever occurs first.

I. Manufacturers

1. Gorman Rupp

2. Accepted equivalent

PART 3–EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Contractor shall install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on pump piping. Install and secure all service lines (level control, air release valve or pump drain lines) as required.

C. After all anchor bolts, piping and control connections are installed, completely fill the grout dam in the pump station base with non-shrink grout.

3.03 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed pump(s) for visual deficiencies

B. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.04 PROTECTION

A. The contractor shall be responsible for provisions to protect the pumps and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 43 21 39 – SOLIDS-HANDLING SUBMERSIBLE PUMPS

INDEX TO

SECTION 43 21 39

SOLIDS-HANDLING SUBMERSIBLE PUMPS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of submersible pump(s) described in this Specification.

B. Pump(s) shall be designed for continuous duty operation, to provide the transfer of fluid volumes as defined in the Pump Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. The manufacturer of the pump shall have a quality management system in place and shall be ISO 9001 certified.

B. The pump and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the pump(s) and associated accessories.

C. The materials and equipment covered by this specification are intended to be standard materials and equipment of demonstrated successful performance and supplied by a manufactured who has been actively engaged in the supply of similarly sized pumps for a minimum of 5 years. Equipment shall be designed and constructed in accordance with the highest standards of the industry and shall be installed in accordance with the manufacturer's recommendations and the Contract Documents.

1.04 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information needed to fully describe the pump(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer

2. Type and Model

3. Rotational speed

4. Major component materials of construction

5. Pump specification describing construction details:

    a. Assembly drawing, nomenclature and material list

    b. Type, manufacturer, model numbers, location and spacing of bearings.

    c. Impeller type, diameter, through-let dimensions, sphere size, number of vanes and identification number.

6. Setting plans shall include:

    a. Installation Drawing

    b. Anchor bolt layout

    c. Anchor bolt dimensions.

    d. Outline dimensions and weights of pumps, bases, motors, and control enclosures.

7. Complete motor performance data including:

    a. Rating, voltage/phase/frequency; design type; service factor; insulation class; motor pole number; actual rotation speed when combined with the specified pumps; current, power factor and active input power (KW) as a continuous function of shaft power from no load to at least 115 percent load; start (max. inrush) current; locked rotor current; NEC code letter; and motor torque as a continuous function through the motor start cycle from no rotation to full speed.

8. Warranty for the proposed equipment.

B. The manufacturer shall indicate, by arrows to points on the Q/H curves, limits recommended for stable operation, between which the pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible and shall be based on actual hydraulic and mechanical characteristics of the units and shall meet the hydraulic performance requirements of the proposed system.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include pump outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS AND TOOLS

A. Provide the following spare parts to the Owner, boxed, marked, and ready for long-term storage:

1. One set of mechanical seal assemblies for each size pump.

2. One complete set of gaskets for each size pump.

3. One complete set of bearings for each size pump.

1.07 PUMP DESIGN (WET WELL MOUNTED)

A. The pump shall be capable of handling raw, unscreened sewage. The discharge elbow shall be permanently installed in the wet well along with the discharge piping. The pumps shall be automatically 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 fastenings to be removed for the purpose and no need for personnel to enter the pump well. Sealing of the pumping unit to the discharge elbow shall be accomplished by a simple linear downward motion of the pumps with the entire weight of the pumping units guided to and pressed tightly against the discharge elbow with a metal to metal watertight contact. No portion of the pump shall bear directly on the floor of the sump, and there shall be no more than one 90-degree bend allowed between the volute discharge flange and sump piping. Guide bars, which shall steer the pump into proper contact with the discharge elbow shall be non-adjustable and shall not bear the weight of the pump.

B. Pumps shall be submersible, single stage, centrifugal type, supplied with integral electric motor, discharge elbow, guide bar brackets and installation accessories. The pumps shall be suitable for pumping raw sewage and shall be designed and fully guaranteed for this use. The fluid temperature range shall be from 35 degrees to 104 degrees F.

C. Materials and Construction Features

1. Pump casing and construction shall incorporate following features:

a. Major pump components shall be of gray cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other casting irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel. All metal surfaces coming into contact with the pumped media, other than stainless steel and/or brass, shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish or two-part epoxy on the exterior of the pump.

b. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Pump/Motor unit mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton Rubber O-rings. Joint sealing will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific bolt torque limit.

c. Rectangular cross sectioned gaskets that require specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

D. Cable entry

1. The cable entry seal design shall provide strain relief and preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of at least one elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the cable entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. For units greater than 100 HP, cable entry shall incorporate dual grommets which shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

2. The cable junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression-type terminals. The use of wire nuts or crimp-type connectors is not acceptable.

E. Bearings

1. The integrated pump/motor shaft shall rotate on two (2) sealed and permanently lubricated bearings. External bearing lubrication ports, which allow bearing contamination and over-packing, will not be allowed. The upper bearing, providing for radial thrust, shall be a single row, roller or ball bearing. The lower bearing shall consist of one double row angular contact bearing for combined axial and radial loads. Minimum L_{10} bearing life shall be 50,000 hours at any usable portion of the pump curve.

F. Motor

1. Each pump shall be driven by a vertical, submersible squirrel cage induction motor, shell type NEMA B design, housed in a dry watertight chamber. The motor and the pump shall be produced by the same manufacturer.

2. The stator winding shall be insulated with moisture resistant Class H insulation, rated for a temperature of 180OC. The stator shall be insulated 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. The use of bolts, pins, screws, or other fastening devices used to locate or hold the stator and that penetrate the stator housing shall be rejected. The motor shall be designed for continuous duty, while handling pumped media of up to 104 degrees F. The motor shall be capable of withstanding at least 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.

3. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with, and supplemental to, external motor overload protection, and shall be connected to the motor control panel.

4. The motor service factor (combined effect of voltage, frequency, viscosity, and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for continuous operation in a 40OC. ambient environment and shall have a NEMA Class B maximum operating temperature rise of 80OC. A motor performance curve shall be provided upon request, showing torque as a function of speed, and current, power factor, speed, input power in KW, and efficiency as a function of shaft power.

5. The motor shall be sized to be non-overloading when the pump is operated at any point on the pump performance characteristic curve. See Section 4.0 for application-specific motor performance requirements.

6. Motors shall be 460 volts, 60 Hz, 3 phase.

7. Motor performance shall conform to the requirements of NEMA MG1 Part 12 and shall be expressed as indicated in NEMA MG1-12.30.

8. Motors shall be premium efficiency type.

9. Inverter Duty:

    a. All motors indicated in the Pump Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

        i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

        ii Inverter grade, 1,600 volt, Class F insulation.

iii Service factor of 1.0 when operated from a VFD.

iv Meeting requirements of NEMA MG1 Part 31.

10. Shaft

a. Pump and motor shaft shall be a solid continuous unit. The pump shaft is an extension of the motor shaft. Couplings and shafts incorporating sleeves shall not be acceptable. The pump shaft shall be completely isolated from the pumped liquid.

11. Motor Cables

a. Pump motor power cables installed shall be oil resistant chloroprene rubber jacketed, type SPC multi-conductor cable, suitable for submersible pump applications and heavy mechanical stresses. The power cable shall also be sized according to NEC and ICEA standards. The total length of each cable shall be a minimum of 40 feet long. Power cables shall each include a ground check conductor (see Sec. 5.14).

G. Guide bars and brackets (wet well mounted)

1. Guide bar(s) shall be provided for guiding the pump unit in raising and lowering. The guide bars shall not support any portion of the weight of the pump. The lower guide bar holders shall be integral with the discharge elbow. Guide cables shall not be considered equal to guide bars and will not be accepted. The pump unit shall be guided on the bars by a guide bracket which shall be an integral part of the pump.

2. The anchor bolts, upper guide bar brackets and cable holder shall be fabricated from 300 series stainless steel.

H. Lifting cable and fittings (wet well mounted)

1. Each pump shall be fitted with 20 feet of AISI 304 stainless steel lifting chain, (or stainless steel wire rope), with necessary fittings, capable of lifting the pump and motor.

I. Manufacturer's Warranty

1. The pump manufacturer shall warrant the pump equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. All equipment, apparatus, and parts furnished shall be warranted for one (1) years, excepting only those items that are normally consumed in service, such as oils, grease, packing, gaskets, O-rings, etc. The pump manufacturer shall be solely responsible for warranty of the pump equipment and all components.

3. Components failing to perform as specified by the engineer or owner, or as represented by the manufacturer, or as proven defective in service during

the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the owner.

4. The warranty shall become effective sixty (60) days after installation, or ninety (90) days after shipment, whichever occurs first.

J. Manufacturers

1. Flygt (No other pump will be acceptable)

PART 2 – PRODUCTS

Not Used.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all pump serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.02 INSTALLATION

A. Contractor shall install, level, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on pump piping. Install and secure all service lines as required.

3.03 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed pump(s) for visual deficiencies

B. Equipment shall be field tested as specified hereinafter. Field testing shall be composed of preliminary tests and acceptance tests. The Contractor shall provide the services of authorized equipment supplier's representatives to conduct all field tests.

C. Prior to acceptance by owner, an operational test of all pumps, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

D. Preliminary tests shall be run on all pumps, motors, and control systems to demonstrate that they are in proper working order.

3.04 ACCEPTANCE TESTS

A. Acceptance tests shall be run to demonstrate that the pumping units, motors and control system meet the following requirements:

1. The pumping units operate as specified without excessive noise, cavitation, vibration, and without overheating of the bearings.

2. All automatic and manual controls function in accordance with the specified requirements.

3. All drive equipment operates without being overloaded.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the pumps and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

INDEX TO

SECTION 44 05 13 – GENERAL REQUIREMENTS FOR EQUIPMENT

SECTION 44 05 13

GENERAL REQUIREMENTS FOR EQUIPMENT

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope:

This section specifies general requirements which are applicable to all mechanical equipment. The Contractor is responsible for ensuring that all mechanical equipment meets the requirements of this section in addition to the specific requirements of each individual equipment specification section.

B. Equipment Lists:

Equipment lists, presented in these specifications and as specified on the drawings, are included for the convenience of the Construction Manager and Contractor and are not complete listings of all equipment, devices and material required to be provided under this contract. The Contractor shall prepare his own material and equipment takeoff lists as necessary to meet the requirements of this project manual.

1.02 QUALITY ASSURANCE

A. Arrangement:

The arrangement of equipment shown on the drawings is based upon information available to the Owner at the time of design and is not intended to show exact dimensions conforming to a specific manufacturer. The drawings are, in part, diagrammatic, and some features of the illustrated equipment installation may require revision to meet actual submitted equipment installation requirements; these may vary significantly from manufacturer to manufacturer. The contractor shall, in determining the cost of installation, include these differences as part of his bid proposal. Structural supports, foundations, connected piping, valves, and electrical conduit specified may have to be altered to accommodate the equipment actually provided. No additional payment shall be made for such revisions and alterations.

B. References:

This section contains references to the documents listed below. They are a part of this section as specified and modified. Where a referenced document cites other standards, such standards are included as references under this section as if referenced directly. In the event of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Unless otherwise specified, references to documents shall mean the documents in effect at the time of Advertisement for Bids or Invitation to Bid (or on the effective date of the Agreement if there were no Bids). If referenced documents have been discontinued by the issuing organization, references to those documents shall mean the replacement documents issued or otherwise identified by that organization or, if there are no replacement documents, the last version of the document before it was discontinued. Where document dates are given in the following listing, references to those documents shall mean the specific document version associated with that date, regardless of whether the document has been superseded by a version with a later date, has been discontinued or has been replaced.

Reference	Title
ABMA Std 9	Load Ratings and Fatigue Life for Ball Bearings
ABMA Std 11	Load Ratings and Fatigue Life for Roller Bearings
ANSI B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ANSI B1.20.1	Pipe Threads, General Purpose (Inch)
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings, (Classes 25, 125, and 250)
ANSI B18.2.1	Square and Hex Bolts and Screws (Inch Series)
ANSI B18.2.2	Square and Hex Nuts (Inch Series)
ANSI S2.19	Mechanical Vibration – Balance Quality Requirements of Rigid Rotors, Part 1: Determination of Permissible Unbalance, Including Marine Applications

C. Unit Responsibility:

The Contractor shall cause equipment assemblies made up of two or more components to be provided as a working unit by the unit responsibility manufacturer, where specified. The unit responsibility manufacturer shall coordinate selection, coordinate design, and shall provide all mechanical equipment assembly components such that all equipment components furnished under the specification for the equipment assembly, and all equipment components specified elsewhere but referenced in the equipment assembly specification, is compatible and operates reliably and properly to achieve the specified performance requirements. Unless otherwise specified, the unit responsibility manufacturer shall be the manufacturer of the driven component equipment in the equipment assembly. The unit responsibility manufacturer is designated in the individual equipment specifications found elsewhere in this project manual. Agents, representatives or other entities that are not a direct division of the driven equipment manufacturing corporation shall not be accepted as a substitute for the driven equipment manufacturer in meeting this requirement. The requirement for unit responsibility shall in no way relieve the Contractor of his responsibility to the Owner for performance of all systems as provided in paragraph 00710–2.04.

The Contractor shall ensure that all equipment assemblies provided for the project are products for which unit responsibility has been accepted by the unit responsibility manufacturer(s), where specified. Unit responsibility for related components in a mechanical equipment assembly does not require or obligate the unit responsibility manufacturer to warranty the workmanship or quality of component products not manufactured by them. Where an individual specification requires the Contractor to furnish a certificate from a unit responsibility manufacturer, such certificate shall conform to the content, form and style of Form 44 05 13–C specified in Section 01 99 90, shall be signed by an officer of the unit responsibility manufacturer's corporation and shall be notarized. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment *even though the equipment may have been installed in the work.*

D. Balance:

Unless specified otherwise, for all machines 10 HP and greater, all rotating elements in motors, pumps, blowers and centrifugal compressors shall be fully assembled, including coupling hubs, before being statically and dynamically balanced. All rotating elements shall be balanced to the following criteria:

$$U_{per} = 6.015\frac{GW}{N}$$

Where:

U_{per}	=	permissible imbalance, ounce–inches, maximum
G	=	Balance quality grade, millimeters per second
W	=	Weight of the balanced assembly, pounds mass
N	=	Maximum operational speed, rpm

Where specified, balancing reports, demonstrating compliance with this requirement, shall be submitted as product data. Equipment balance quality grade shall be G 2.5 (G = 2.5 mm/sec) or better in accordance with ANSI S2.19.

PART 2 – PRODUCTS

2.01 FLANGES AND PIPE THREADS

A. Flanges on equipment and appurtenances provided under this section shall conform in dimensions and drilling to ANSI B16.1, Class 125. Pipe threads shall conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.

Threaded flanges shall have a standard taper pipe thread conforming to ANSI B1.20.1. Unless otherwise specified, flanges shall be flat faced.

Flange assembly bolts shall be heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Threads shall be Unified Screw Threads, Standard Coarse Thread Series, Class 2A and 2B, ANSI B1.1.

A. Bearings

Unless otherwise specified, equipment bearings shall be oil or grease lubricated, ball or roller type, designed to withstand the stresses of the service specified. Each bearing shall be rated in accordance with the latest revisions of ABMA Methods of Evaluating Load Ratings of Ball and Roller Bearings. Unless otherwise specified, equipment bearings shall have a minimum L–10 rating life of 50,000 hours. The rating life shall be determined using the maximum equipment operating speed.

Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic alemite type.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 60 °C and shall be equipped with a filler pipe and an external level indicator gage.

All bearings accessible to touch, and located within seven feet measured vertically from floor or working level or within 15 inches measured horizontally from stairways, ramps, fixed ladders or other access structures, shall either incorporate bearing housings with sufficient cooling to maintain surface temperature at 65 °C or less for continuous operation at bearing rated load and a 50 °C ambient temperature or shall be provided with appropriate shielding shall be provided that will prevent inadvertent human contact.

2.02 V–BELT ASSEMBLIES

A. Unless otherwise specified, V–belt assemblies shall be Dodge Dyna–V belts with matching Dyna–V sheaves and Dodge Taper–lock bushings, Wood's Ultra V–belts with matching Ultra–V sheaves and Wood's Sure–Grip bushings, or equal.

Sheaves and bushings shall be statically balanced. Additionally, sheaves and bushings which operate at a peripheral speed of more than 5500 feet per minute shall be dynamically balanced. Sheaves shall be separately mounted on their bushings by means of three pull–up grub or cap tightening screws. Bushings shall be key seated to the drive shaft.

Belts shall be selected for not less than 150 percent of rated driver horsepower and, where two sheaves sizes are specified, shall be capable of operating with either set of sheaves. Belts shall be of the antistatic type where explosion proof equipment is specified.

2.03 PUMP SHAFT SEALS

A. General:

Seals for water and wastewater pump shafts shall be either stuffing box or mechanical seals. For industrial wastewater service, or for fluids other than water or municipal wastewater, the recommendations of the seal manufacturer shall be followed for selection of appropriate seals. Unless specified otherwise, stuffing boxes and mechanical seals shall conform to the requirements set forth in this paragraph.

B. Mechanical Seals:

Unless otherwise specified in the detailed pump specifications, mechanical seals shall be split mechanical seals requiring no field assembly, other than assembly around the shaft and insertion into the pump. They shall be self–aligning, and self–centering, single seals. They shall be of a nondestructive (nonfretting) type requiring no wearing sleeve for the shaft. Shafts for pumps specified with mechanical seals shall be furnished with no reduction in size through the seal area (no shaft sleeve). Where the detailed specifications call for cartridge instead of split seals, all other requirements of this paragraph apply.

Metal parts shall be Type 316 or 316L stainless steel. Springs shall be Hastelloy C, Elgiloy, or other Duplex SS selected for resistance to chloride attack. Rotary faces shall be silicon carbide or chrome oxide. Stationary faces shall be silicon carbide for solids bearing fluid service and carbon for clean water service. Elastomers shall be ethylene propylene or fluorocarbon. Mechanical seals shall be suitable for operation between full vacuum (0 psia) up to 200 percent of the maximum specified operating pressure, but in any event not less than 200 psig.

Seal chambers shall be provided with vented solids removal restriction bushings except for enclosed line shaft pumps where the seal barrier fluid is used for line shaft bearing lubrication. The bushing shall both control the amount of flushing water flow and restrict solids and gas accumulation from the seal face area.

Candidate seals include:

1. Chesterton 442 seals provided with Chesterton/SpiralTrac solids removal restriction bushings Version N or D, as recommended by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

2. AESSEAL RDS seals with Cyclops bushing.

3. John Crane 3710 seals with Type 24SL bushing.

   Seals on pumps for contaminated water service (sludge, grit, wastewater, scum, reclaimed water, etc.) shall be drilled and tapped for connection of a clean water flushing supply.

   Seals for all vertical pumps (whether column or volute type) shall be provided with a second flush connection. Vertical pumps shall have a vent valve attached to the mechanical seal to eliminate air from the seal chamber prior to pump start; start–up procedures shall include venting instructions; and for remotely started pumps, the vent system shall be automated. Where specified in the detailed specifications, permissive confirmation automatic vent systems shall be provided.

C. Shaft Packing:

Where shaft packing is specified, stuffing boxes shall be tapped to permit introduction of seal liquid and shall hold a minimum of five rows of packing. Stuffing boxes shall be face attached. Stuffing box and shaft shall be suitable for field installation, without machining or other modifications, of the mechanical seal specified in paragraph 44 05 13–2.04.B for the applicable pump and operating conditions.

Unless otherwise specified, lantern rings shall be bronze or Teflon, packing shall be die–molded packing rings of non–asbestos material suitable for the intended service and as recommended by the manufacturer, and glands shall be bronze, two piece split construction. Lantern rings shall be of two–piece construction and shall be provided with tapped holes to facilitate removal. Lantern rings shall be drilled and tapped 1/4 NC–20. The impeller end of the packing on all but line shaft pumps with external source water lubricated bearings shall be fitted with a SpiralTrac, Version P packing protection system as manufactured by EnviroSeal Engineering Products, Ltd, Nova Scotia, Canada.

The section of each shaft or impeller hub that extends through or into the stuffing box shall be fitted with a replaceable stainless-steel sleeve with a Brinell hardness of not less than 500. The sleeve shall be held to the shaft to prevent rotation and shall be gasketed to prevent leakage between the shaft and the sleeve. Minimum shaft sleeve thickness shall be 3/8 inch.

2.04 COUPLINGS

A. Unless otherwise specified in the particular equipment sections, equipment with a driver greater than 1/2 HP, and where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have its two shafts connected by a flexible coupling which can accommodate angular misalignment, parallel misalignment and end float, and which cushions shock loads and dampens torsional vibrations. The flexible member shall consist of a tire with synthetic tension members bonded together in rubber. The flexible member shall be attached to flanges by means of clamping rings and cap screws, and the flanges shall be attached to the stub shaft by means of taper lock bushings which shall give the equivalent of a shrunk–on fit. There shall be no metal–to–metal contact between the driver and the driven unit. Each coupling shall be sized and provided as recommended by the coupling manufacturer for the specific application, considering horsepower, speed of rotation, and type of service.

Where torque or horsepower capacities of couplings of the foregoing type is exceeded, Thomas–Rex, Falk Steel Flex, or equal, couplings will be acceptable provided they are sized in accordance with the equipment manufacturer's recommendations and sizing data are submitted. They shall be installed in conformance to the coupling manufacturer's instructions.

2.05 GUARDS

A. Exposed moving parts shall be provided with guards which meet all applicable OSHA requirements. Guards shall be fabricated of 14–gage steel, 1/2–13–15 expanded metal screen to provide visual inspection of moving parts without removal of the guard. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Reinforced holes shall be provided. Lube fittings shall be extended through guards.

2.06 CAUTION SIGNS

A. Equipment with guarded moving parts which operates automatically or by remote control shall be identified by signs reading "CAUTION – AUTOMATIC EQUIPMENT MAY START AT ANY TIME". Signs shall be constructed of fiberglass material; minimum 1/8-inch-thick, rigid, suitable for post mounting. Letters shall be white on a red background. The sign size and pattern shall be as shown on the drawings. Signs shall be installed near guarded moving parts.

2.07 GAGE TAPS, TEST PLUGS, AND GAGES

A. Gage taps shall be provided on the suction and discharge sides of pumps, blowers and compressors. Pressure and vacuum gages shall be provided where specified. Gage taps, test plugs, and gages shall be as specified in Division 40.

2.08 NAMEPLATES

A. Nameplates shall be provided on each item of equipment and shall contain the specified equipment name or abbreviation and equipment number. Equipment nameplates shall be engraved or stamped stainless steel and fastened to the equipment in an accessible and visible location with stainless steel screws or drive pins.

2.09 LUBRICANTS

A. The Contractor shall provide for each item of mechanical equipment a supply of the required lubricant adequate to last through the specified commissioning period. Lubricants shall be of the type recommended by the equipment manufacturer and shall be products of the Owner's current lubricant supplier. The Contractor shall limit the various types of lubricants by consolidating them, with the equipment manufacturer's approval, into the least number of different types. Not less than 90 days before the date shown in his construction schedule for starting, testing and adjusting equipment, the Contractor shall provide the Owner with three copies of a list showing the required lubricants, after consolidation, for each item of mechanical equipment. The list shall show estimated quantity of lubricant needed for a full year's operation, assuming the equipment will be operating continuously.

2.10 ANCHOR BOLTS

A. Anchor bolts shall be designed for lateral forces for both pullout and shear per the structural specifications.

2.11 SPARE PARTS

A. Spare parts, wherever required by detailed specification sections, shall be stored in accordance with the provisions of this paragraph. Spare parts shall be tagged by project equipment number and identified by 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.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation of equipment accessories included in this section shall be as recommended by the equipment manufacturer unless otherwise specified in the individual equipment specification section.

END OF SECTION

SECTION 44 11 20.18

ODOR CONTROL
EXTRUDED ALUMINIUM FLAT COVER

PART 1 – GENERAL

1.01 DESCRIPTION

A. This section defines the design requirements for the aluminum extruded flat cover(s) as described in the contract drawings and documents.

1.02 SUBMITTALS

A. Before executing any of the work in this section, prints or drawings shall be submitted to the engineer showing dimensions, sizes, thickness, gauges, materials, finishes, joint attachment and erection procedure. Drawings shall bear the seal and signature of the design engineer, registered in the state of the project.

B. A complete set of design calculations for the cover(s) shall also be submitted. These calculations shall be signed by a registered professional engineer registered in the state of the project. Provide shop drawings to Engineer for approval. All work shall be fabricated and erected in accordance with the approved drawings.

C. Certification that the specified material alloys, sizes and quantities have been furnished shall be submitted upon completion of the project.

1.03 REFERENCES

A. The following codes and standards form a part of this section to the extent specified herein:

1. ASTM C–864–90 Standard Specifications for Preformed Gasket and Sealing Material

2. Aluminum Association Specifications for Aluminum Structures

3. Aluminum Association Aluminum Design Manual; Specifications and Guidelines for Aluminum Structures

4. ASCE 8–02 Specification for the Design of Cold–Formed Stainless Steel Structural Members

5. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

6. Federal Specification TT – S – 00230C

PART 2 – PRODUCTS

2.01 DESCRIPTION

A. The extruded flat covers shall be clear–span and self–supporting from the peripheral structure. The cover system shall consist of removable panels each weighing no more than 150 pounds. The required lifting force per panel shall not exceed the dead weight of the panel. The extruded panels utilize specially extruded panel structural members, slip–resistant top planks with stiffeners, and integral perimeter flashing/endcaps. Both male and female panels must independently be designed to meet both the design loading and the deflection limits specified herein. Elastomeric weatherseal gasket shall form a continuous substantially watertight seal along all panel edges. The gaskets shall be fully enclosed to prevent ultraviolet exposure.

B. Each panel must be able to be removed without needing to remove more than the two adjacent panels. The need for removing separate flashing or "hold–down" extrusions longer than the width of the panel is prohibited. Primary panel support members shall be integral to the panels. Upon removal of the panels, the entire area beneath the panels shall be exposed and no substructure in the form of beams or box–beams shall remain in the basin(s) to be covered. To facilitate removal, panels shall incorporate integral lifting handles. Handles shall be located at both ends of the cover panels and shall not penetrate the cover panels or pond water.

C. The extruded flat cover shall have an integral bi–directional slip resistant surface which extends a minimum of 0.1–inch above the panel surface. Raised surfaces without the use of texturing to achieve slip resistance are not acceptable. The use of checkered plate, paint, tape, sandblasting, or other applied systems to achieve the slip resistant surface is expressly prohibited.

D. The extruded flat cover system shall be Flush Mount, with the covers slip resistant walking surface flush with the top of the basin or tank wall. Lifting handles shall be integral with the panel endcaps.

E. All metal components of the flat cover structure shall be aluminum or 300 series stainless steel. No galvanized, painted, or plated steel shall be used. The use of structural plastic is expressly prohibited. Dissimilar materials in the supporting structure shall be isolated from the aluminum flat cover by means of a compatible elastomeric gasket.

F. The use of structural members in contact with the contents of the tank is expressly prohibited.

G. The design shall prevent water pooling which may result in over–stressing the flat cover.

H. The extruded flat cover will have a mill finish surface.

I. Fasteners shall be designed with a factor of safety of 2.34 on ultimate strength and 1.65 on yield strength.

J. The removable extruded flat cover system shall be designed to be substantially air and water tight under the specified design loading conditions

2.02 EXPERIENCE/QUALIFICATIONS

A. No equipment shall be supplied by any manufacturer not regularly engaged in the manufacturing and production of extruded flat cover(s) in the size and character herein specified. The manufacturer must have designed, manufactured and installed at least one (1) formed panel flat cover of the same type and size as unit(s) specified herein. This flat cover must be in satisfactory use for a period not less than ten (10) years.

B. The cover manufacturer must own and operate its own US–based manufacturing facility, and the use of a fabrication facility that is not US–based and/or owned and operated by the cover manufacturer is expressly prohibited. Manufactures that do not meet these qualifications will not be considered.

C. The cover manufacturer must be ISO 9001 certified.

2.03 MATERIALS

A. The following is a summary of approved materials and/or material specifications. All aluminum alloys shall be as defined by the Aluminum Association and published in the ALUMINUM STANDARDS AND DATA.

1. **Bolts and Fasteners** – Bolts shall be 300 series stainless steel per ASTM F593, Alloy Group 1. Lock bolts shall be 7075–T73 aluminum or 305 stainless steel. Screws shall be aluminum or 300 series stainless steel.

2. **Structural Shapes** – Aluminum structural shapes shall be alloy 6061–T6 or 6063–T6. Load supporting surfaces shall be 0.1–inch minimum thickness.

3. **Miscellaneous Shapes** – Miscellaneous aluminum shapes shall be alloy 6061–T6 or 6063–T6.

4. **Gaskets** – All gaskets shall be Neoprene conforming to ASTM C–864–90, resistant to ozone and shielded from exposure to ultraviolet light. The gaskets must have a ¼" minimum thickness.

5. **Sealant** – All sealants shall be silicone, GE Silpruf SCS 9000.09 and resistant to ozone and ultraviolet light and conform to Federal Specification TT–S–00230C.

6. **Miscellaneous Penetration Seals**– All other penetration seals shall be weatherproof rubber seals.

7. **Support Bearings** – Bearings at the supports (if required) shall conform to AASHTO Division 2 Section 25. Acceptable bearing surfaces for sliding bearings are Teflon to stainless steel only. In order to avoid damage to the

Teflon and to reduce the coefficient of bearing friction, Teflon shall not bear on aluminum surfaces.

2.04 DESIGN LOADS

A. The entire extruded flat cover structure shall be designed to sustain the loads specified herein, within the stress limitations of the Aluminum Association Aluminum Design Manual. In no case shall the formed panel flat cover be designed for any loads less than those specified by the local building code and/or local amendments.

B. The load cases to be considered shall be those described below unless more severe loads are specified by the purchaser.

1. **Dead Load** – The dead load shall be defined as the weight of the structure and all permanently attached to and supported by the structure.

2. **Live Load** – As designated on the drawings.

3. **Snow Load** – As required per ASCE 7–10, but not less than required by local building codes and/or local amendments.

   Importance Factor (I) = 1.0 or greater per ASCE 7–10 Table 1–1.
   Exposure Factor (C_e) = 1.0 or greater per ASCE 7–10 Table 7–2.
   Thermal Factor (C_t) = 1.2.

4. **Non–Uniform Snow Load** – As required per ASCE 7–10 but not less than required by local building codes and/or local amendments.

5. **Wind Load** – As required per ASCE 7–10, but not less than 157 MPH.

   Exposure Factor = C

6. **Vacuum/Pressure Load** – N/A.

7. **Load Combinations** – As required per ASCE 7–10 Section 2.4.1.

8. **Temperature** – The load combinations listed above shall be considered for a temperature change of 100 degrees F below the installation temperature and 100 degrees F above the installation temperature and for a material temperature range of 40 degrees F below 0 to 160 degrees F above zero.

9. **Panel Design Load** – In addition to the above-mentioned loads and load combinations, the aluminum panels shall be designed for a **300 pound** load distributed over one square foot at any location. This load is to be taken as acting separately and not simultaneously with other design loads.

10. **Deflection** – For the above loads and load combinations, the deflection of all components (structural and cladding) shall not exceed L/240 with L equal to the span of the component. This deflection limit applies not only

to the flat cover as a whole, but also to the decking of the cover spanning between the supporting edges of each panel or module. Calculations stamped by a Georgia registered Professional Engineer shall be provided at the time of submittal to ensure that this requirement has been met.

2.05 MANUFACTURERS

A. The aluminum extruded flat cover shall be as manufactured by TemcorConservatek – Gardena, California (310) 353–5100 or Conroe, Texas (936) 539–1747.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All work shall be executed by skilled mechanics with a supervisor experienced in the erection of extruded flat covers. The flat cover shall be erected plumb and level and in proper alignment.

3.02 WARRANTY

A. The extruded flat cover manufacturer shall warrant that the work described herein shall be free from defects, workmanship and material. The flat cover manufacturer shall replace, or repair only faulty workmanship or defective material furnished by it that is reported to it within one (1) year from the date of completion of this scope of work.

END OF SECTION

INDEX TO

SECTION 44 42 19 – POSITIVE DISPLACEMENT BLOWERS

SECTION 44 42 19

POSITIVE DISPLACEMENT BLOWERS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor

1.02 SCOPE

A. Provide all labor, materials, tools and equipment required to furnish and install, in good workmanlike manner, Positive-Displacement Rotary 3-lobe blower units with integrated pulsation cancellation. Blower units shall be complete and operational.

B. Blowers(s) shall be designed for continuous duty operation, to provide the air volumes as defined in the Blower Schedules in this Specification.

1.03 QUALITY ASSURANCE

A. Blowers and appurtenances shall be supplied by a CE certified blower manufacturer with a Quality Control System certified in accordance with ISO 9001. Units shall be furnished as a complete system

B. All equipment furnished under this section shall be furnished by a single manufacturer who shall assume complete responsibility for the design and performance of the equipment. The manufacturer shall have a minimum of five (5) years experience in producing blower equipment and shall produce evidence of at least five (5) installations of similar size in satisfactory operation in the United States.

1.04 SUBMITTAL INFORMATION

A. Provide a complete set of submittal information in PDF format. All pertinent information needed to fully describe the blowers(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. ASME PTC – 9 Performance Test Results
2. Manufacturer of all components supplied
3. Model numbers of all component supplied
4. Rotational speed
5. Capacity in scfm and icfm
6. Discharge pressure
7. dB(A) noise pressure level
8. Weights of each item of equipment
9. Major component materials of construction
10. Blower specification describing construction details
11. HP required at rated capacity and pressure
12. Outline Dimension Drawing
13. Installation Drawing
14. Complete performance data showing capacity and power input
15. Electrical Data that includes
    a. Motor rating, hp
    b. Motor temperature rating
    c. Motor full load rotational speed
    d. Motor full load current
    e. Motor locked rotor current
    f. Motor performance curves showing speed, efficiency, current, power, etc.
16. List of recommended spare parts broken down into on hand parts and long term for 2 years operation and 3 to 5 years operation.
17. Manufacturer's warranty

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include blower and blower package outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a trouble shooting guide.

1.06 SPARE PARTS AND TOOLS

A. Provide the following spare parts to the Owner, boxed, marked, and ready for long-term storage:

1. One complete set of gaskets, seals, V-belts, as required for each blower size.

2. One additional set of filter elements for each air inlet filter for each blower size

B. Spare parts shall be properly bound and labeled for easy identification without opening the packaging and suitably protected for long-term storage in a humid environment.

C. One set of Tools required for changing oil and performing belt maintenance shall be provided for each blower size.

PART 2 – PRODUCTS

2.01 BLOWER DESIGN

A. Site Conditions

1. Elevation: 25 feet above sea level

2. Maximum inlet temperature: [95] deg F

3. Maximum humidity (at maximum temperature): [60] %RH

B. Blower Schedules: Blower packages shall be provided to meet to following conditions and duty points.

Blower Name	MBR Zone
Number of Blowers	5 (4 duty and 1 standby)
Maximum Blower Capacity	TBD SCFM
Minimum Blower Capacity	TBD SCFM
Maximum Differential Pressure (excluding internal blower losses)	TBD psig
Indoor/outdoor	outdoor
Hazardous Location	No
VFD Controlled	Yes

Blower Name	Pre-Aeration (Process) Blower
Number of Blowers	TBD
Maximum Blower Capacity	TBD SCFM
Minimum Blower Capacity	TBD SCFM
Maximum Differential Pressure (excluding internal blower losses)	TBD psig
Indoor/outdoor	Outdoor
Hazardous Location	No
VFD Controlled	Yes

Blower Name	WAS/MBT Basin Blowers
Number of Blowers	TBD
Maximum Blower Capacity	TBD SCFM
Minimum Blower Capacity	TBD SCFM
Maximum Differential Pressure (excluding internal blower losses)	TBD psig
Indoor/outdoor	Outdoor
Hazardous Location	No
VFD Controlled	Yes

C. Blowers shall be sized so that maximum duty point does not exceed 90% of maximum blower speed.

D. Blowers shall be rotary-lobe, dynamically and statically balanced, tri-lobe design with an equalization chamber integral to the blower housing.

E. The blower rotors are to be balanced according to ISO 1940 class Q 2.5. With respect to acceptable vibration levels, the blowers must operate between effective vibration speeds of 2.8 to 7.0 mm/sec. (0.11 to 0.276 inches/sec.) measured at the bearing housing per VDI standard 2056. For acceptance, all blowers must conform to ISO 2373, Machine Group T.

F. Each blower shall be factory tested per ASME PTC-9 performance test to verify flow, BHP, and slip at design conditions as well as blower maximum conditions. Slip test only shall not be acceptable. The acceptance criteria are +5% tolerance on power and –5% tolerance on flow regardless of the size of the machine. The performance test can be performed in accordance with other internationally recognized standards, such as ISO.

G. Materials and Construction Features

1. Blower Housing

a. Housing shall be fabricated of close-grained high strength cast iron construction with DIN inlet and outlet connections, provided with a built-in "equalization" chamber, and drive-end head-plate integral to the cylinder.

2. Rotors

   a. Rotors shall be stiff-shaft design with the first lateral critical speed at least 120% of the maximum allowable speed.

   b. Any torsional natural frequency shall be at least 10% above or 10% below the operating speed range of the blower.

   c. The rotor and shaft assembly shall be a one-piece design constructed of ductile iron.

   d. Rotors shall be solid or have closed ends.

   e. Rotors shall have an integral sealing strip for improved efficiency.

3. Timing Gears

   a. Timing gears shall be spur type, precision ground, hardened and carburized, AGMA Grade 11 equivalent quality or better, with minimum service factor of 1.7 at the maximum operating point.

   b. Gears shall be secured by bolting and interference fit on precision ground tapered shaft ends.

4. Bearings

   a. Bearing shall be high standard cylindrical roller bearings with an L-10 Life of at least 40,000 hours at maximum speed and maximum differential pressure.

5. Seals at Rotor Chamber

   a. Rotor chamber seals shall be non-rubbing, vented, labyrinth-type seals. Each seal assembly shall consist of four (4) hardened steel piston rings, an oil deflector, a grooved labyrinth sleeve, and casing wear ring. There are a total of (16) sixteen piston ring seals.

   b. Provision for venting to atmosphere between the oil-side and the air-side seals shall be included.

   c. The use of lip-type seals for internal rotor shaft sealing is not acceptable.

   d. Replaceable casing wear rings to protect the seal bores in the headplates are required.

6. Input Shaft Lip Seal

   a. The input shaft seal shall be a lip type seal

   b. The seal assembly must include a shaft sleeve, precision ground, with a titanium dioxide coating and a relief taper at the dust lip to reduce friction and heat.

c. The seal assembly must be fully serviceable without removing the front oil chamber cover.

2.02 BLOWER PACKAGE

A. Each blower shall be supplied with a sound enclosure covering the entire blower package including the drive motor, the inlet silencer, and the discharge silencer. The sound enclosure must be designed for easy inspection and maintenance of all blower package components. The enclosure shall provide suitable protection for outdoor installation under the specified site conditions.

B. The free field noise pressure at 3 feet from the enclosure shall not exceed [80] dB(A) at the listed operating conditions.

C. The packages shall be driven through V-belts and sheaves. The drive assembly shall be of the high capacity type, oil and heat resistant, with a minimum service factor of 1.5.

D. Automatic tensioning of the V-belts by use of a pivoting, swing frame motor base with adjustable spring assistance and visual indication of V-belt tension shall be provided to insure the V-belts remain properly tensioned with minimal maintenance and to extend V-belt, sheave, and bearing life.

E. The drive guard shall be the manufacturer's standard sheet metal with provision for ventilation. The installed guard shall be fully enclosed, easily removable, and designed to meet current OSHA recommendations and CE standards.

F. The base shall be an elevated, rigid, fabricated steel design with a solid sub-base. The discharge silencer must be integral to the frame in order to minimize space requirements.

G. To prevent transmission of vibration and noise, the base shall include vibration isolators made of rubber in a steel footing. The vibration isolators are to be mounted between the blower base and the package sub-base.

H. Each blower shall be supplied with a combination inlet filter and silencer. Filter element shall be washable by maintenance personnel as a preventative maintenance procedure.

I. Each blower shall be supplied with one inlet silencer. The inlet silencer shall be a combination chamber and absorptive design for maximum sound attenuation. Inlet silencer performance losses shall be included by the blower vendor in the blower performance calculation.

J. Each blower shall be supplied with a discharge silencer. The discharge silencer shall be designed to reduce the pressure noise level emitted by the piping leaving the blower package to 85dB(A) over the entire range of operation, based on a carbon steel, schedule 40 piping of a diameter equal to the blower package nominal connection size.

K. Each blower shall be supplied with a single pressure safety valve on the discharge side of the blower mounted downstream of the discharge silencer and upstream of the check valve. The safety valve shall be set to protect the blower from exceeding its maximum pressure rating. The materials selected for the valve internals shall enable safe and reliable operation at the site conditions. The single valve shall be sized to pass 100% of the design flow. The valve shall be field adjustable, spring loaded, and have a proportional operating characteristic with respect to the pressure set point.

L. Each blower shall be supplied with one check valve that shall be installed on the discharge line. The vendor shall include the pressure losses produced by the check valve in the blower performance calculation.

M. Each blower package shall be supplied with flexible connector(s) or connection to the plant piping. The flexible connectors shall be sized for a standard, schedule 40 pipe diameter and shall prevent the transmission of noise and vibrations from the blower package into the piping. The flexible connectors shall be suitable for the maximum operating temperature and pressure ratings of the equipment in the air stream.

N. A sound enclosure shall be provided as standard, shipped fully assembled and shall be the product of the blower manufacturer to insure proper integration. The sound enclosure shall be sheet steel construction with powder coat finish. The enclosure shall have hinged and/or removable panels to allow maintenance access. Panels shall incorporate locking closures.

O. The enclosure shall have acoustic foam insulation. The sound absorbing material must be self-extinguishing and meet the standard of UL 94, Section HFI.

P. At a minimum, each blower shall be supplied with the following instrumentation:

1. One pressure gauge to measure the discharge pressure. The pressure gauge shall read 0-15 PSI. The pressure gauge shall have a stainless steel case and be glycerin-filled for pulsation dampening.

2. A filter maintenance indicator.

3. One combination temperature gauge/switch, with adjustable switching point and contact, to measure the discharge temperature. As an option, a separate temperature gauge and switch may be supplied.

Q. Blower Motor

1. All blower motors shall be supplied mounted and aligned within the blower enclosures.

2. Motors shall be 460 volts, 60 Hz, 3 phase.

3. The motors shall have NEMA Class F insulation and limited to Class B rise.

4. The blower motors shall be NEMA Premium efficiency type.

5. Winding Over Temperature Protection

a. Embedded thermostats, one (1) per winding, normally closed contact, shall be provided for an external thermal alarm or motor cut out for all motors 40 Hp and above, unless otherwise shown. Thermal cutout leads shall be brought out to the motor terminal connection box. Connection of the over-temperature protection to the control system is the responsibility of the Contractor.

6. Blower motors shall have a 1.15 service factor rating. The blower brake horsepower requirements shall not exceed the motor name plate horsepower under the operating conditions listed in the Blower Schedule.

7. Inverter Duty:

   a. All motors for blowers indicated in the Blower Schedule to be powered from variable-frequency alternating-current drives (VFD) shall have the following features in addition to those listed above:

      i Designed for used on pulse width modulated (PWM) VFD without external filters or cable length limitations.

      ii Inverter grade, 1,600 volt, Class F insulation.

      iii Service factor of 1.0 when operated from a VFD.

      iv Meeting requirements of NEMA MG1 Part 31.

R. Blower Enclosure Cooling Fan (when required)

1. When required for the proper functioning of the blower, blower enclosure fan(s) shall be mounted in the sound attenuating enclosure.

2. When blower enclosure fans are motor-operated, each fan shall be driven by a separate motor to ensure adequate cooling at all blower operating speeds.

3. Enclosure cooling fan motors shall be of the same operating voltage as the blower motor.

S. Manufacturer's Warranty

1. The blower manufacturer shall warrant the blower equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below.

2. Rotary blowers shall be warranted against defects in material and workmanship for a period of (60) sixty-months from shipment. All other package components shall be warranted for a period of (18) eighteen months from shipment or (12) twelve months from start-up, whichever occurs first.

T. Manufacturers

1. Aerzen

2. Kaeser

3. Approved equal

PART 3 – EXECUTION

3.01 FACTORY TESTING

A. Manufacturer shall factory-test equipment to detect any defects and demonstrate that they will function satisfactorily under the conditions specified. Testing shall include slip testing and mechanical run testing at full pressure and full speed. Manufacturer shall not supply blowers that do not meet the performance standards

3.02 EXAMINATION

A. Contractor shall off-load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off-loading, contractor shall inspect complete blower package and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.03 INSTALLATION

A. Contractor shall install, level, and align blowers package(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

B. Sufficient supports and thrust blocks shall be installed to prevent strain and vibration on blower piping. Install and secure all service lines as required.

3.04 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed blower packages(s) for visual deficiencies

B. Prior to acceptance by owner, an operational test of all blowerss, drives, and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the blower package(s) and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 44 42 46 – SUBMERSIBLE MIXERS

SECTION 44 42 46

SUBMERSIBLE MIXERS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

45 50 00 Membrane Bioreactor

1.02 SCOPE

A. Furnish all labor, materials, tools and equipment necessary for complete installation of submersible mixer(s) described in this Specification.

B. Each mixer shall include a submersible power cable, guide rail system, power cable support, lifting cable, and controls as required in this specification.

C. Mixer(s) shall be designed for continuous duty operation, to provide complete mixing within the basin volumes defined, and to keep solids from settling in the tank.

1.03 QUALITY ASSURANCE

A. The mixer and accessories specified herein shall be the design and fabrication of a single manufacturer which shall have the sole source responsibility for the mixer(s) and associated accessories. The mixer should be supplied by MBR supplier only.

1.04 SUBMITTAL INFORMATION

A. Provide a complete sets of submittal information in PDF format. All pertinent information needed to fully describe the mixer(s) and accessories shall be included in the submittal. Where multiple options are included within standard literature, project specific part numbers and options shall be highlighted by enclosing the project-specific information (circling, clouding, text boxes) and other information shall be crossed out. Any deviations to these specifications must be listed on a separate page referencing the specification section with a brief description of the deviation and why it is equal to or superior to what is specified. Submittals for each size and type shall include, but not be limited to the following:

1. Name of manufacturer.

2. Type and Model.

3. Rotational speed.

4. Major component materials of construction.

5. Mixer specification describing construction details.

6. Outline Dimension Drawing.

7. Installation Drawing.

8. Complete performance data showing capacity and power input.

9. Electrical Data that includes.

   a. Motor rating, HP.

   b. Motor temperature rating.

   c. Motor full load rotational speed.

   d. Motor full load current.

   e. Motor locked rotor current.

   f. Power cable data.

10. Motor performance curves showing speed, efficiency, current, power, etc.

11. Moisture sensor protection characteristics and wiring diagram.

12. Mixer Mast Assembly.

    a. Hoist and Mast Assembly specification.

    b. Hoist details and materials of construction.

    c. Mast assembly details and materials of construction.

1.05 OPERATION & MAINTENANCE MANUALS

A. Furnish a complete Installation, Operation & Maintenance Manual in PDF form. Manuals shall include mixer outline dimensions, motor data, nameplate data, safety instructions, transportation and storage information, general design information, mounting & installation information, electrical connection information, commissioning instructions, maintenance information and a troubleshooting guide.

1.06 SPARE PARTS

A. Furnish one complete set of mechanical, lip and O–ring seals for each mixer type or size furnished. All spare parts shall be provided in a separate container that clearly identifies to which mixer they belong.

PART 2 – PRODUCTS

2.01 MIXER DESIGN

A. Service

1. All mixing equipment shall be designed to satisfactorily operate continuously in a submerged waste treatment plant environment.

2. The mixer(s) shall be designed to be easily raised, lowered, removed for inspection or service, and rotated horizontally without the need for personnel to enter the tank. A single cast sliding guide bracket shall be an integral part of each mixer. The single cast guide bracket shall guide the mixer into position and be capable of carrying the entire weight of the mixer and the maximum loads created by the mixer. The mixer, with its appurtenances and power cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 feet. FM–approved mixers have a depth limit of 57 feet.

B. Performance

1. The mixing equipment shall be designed based on the following design conditions and criterion:

Basins Name	**Anaerobic, Anoxic, Post Anoxic Basins**
Number of Basins	3
Fluid to be mixed	RAS, Influent flow, ML
Hazardous Location	No
Solids Concentration (mg/l)	6,000 –15,000
Basin Dia. (ft)	Refer the layout.
Number of Mixers	2- each tank
Minimum SWD (ft)	5
Maximum SWD (ft)	21
Overall Tank Depth (to top of wall, ft)	23

C. General

1. Each mixer shall be of the closed–coupled, direct drive, submersible type design. All components of mixer, including the motor and power cable shall be capable of continuous underwater operation while the mixer propeller is completely submerged. In addition, all components of the mixer shall be capable of operation in air, completely unsubmerged for two hours.

D. Materials

1. Major mixer components shall be of 316 stainless steel construction. All exposed hardware shall be 316 stainless steel. All surfaces coming into

contact with tank fluid other than stainless steel shall be protected by a two–part epoxy paint.

E. Propeller

1. The propeller shall be 316 stainless steel having two or three self–cleaning backward–curved blades capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater treatment applications. Each blade shall be precision–cut and welded to the hub. Propeller shall be dynamically balanced, so the propeller imbalance does not exceed ISO 1940 G6.3 tolerances to prevent excessive vibrations.

F. Fasteners

1. All bolts, nuts, washers and other fasteners shall be 316 stainless steel.

G. Cable Entry

1. The electrical power cable entry shall be an integral part of the slide bracket.

2. The cable entry seal system shall be composed of elastomer grommets flanked by stainless steel washers all designed with close clearance fits against the cable outside diameter and the cable entry inside diameter.

3. A cable entry seal system shall provide a watertight seal between the electrical connection chamber and motor preventing fluid leakage into the motor.

4. Epoxy cable entry sealing systems are not considered equal or acceptable.

H. Shaft

1. The propeller and motor shaft shall be in integral unit. The shaft material shall be 316 stainless steel designed to meet the maximum loads generated by the mixer.

I. Propeller Shaft Seal

1. The mixer shall be provided with a double seal system consisting of a mechanical seal on the propeller (outer) side of the oil chamber and second mechanical seal on the motor (inner) side, each working independently of the other.

2. The mechanical seal shall require neither maintenance nor adjustment, shall not be damaged when the mixer is run dry, shall be easy to check and replace, shall be capable of running in either direction without damage, and be readily available from any major seal manufacturer. Shaft seals that rely on the tank fluid as a lubricant will not be considered acceptable or equal.

J. Bearings

1. The mixer shall rotate on two permanently lubricated bearings. Bearings shall be lubricated for life design and sized to transfer all radial and axial loads to the mixer housing and minimize shaft deflection for increased bearing and seal life.

2. Bearings shall not require pre–loading and shall be maintenance–free with a minimum L10 (B10) bearing life of 100,000 hours at design conditions. Mixer's having bearings that require pre–loading or periodic lubrication will not be considered acceptable or equal.

K. Sealing of Mating Surfaces

1. All mating surfaces of the mixer shall be machined and fitted with static nitrile or viton O–rings providing watertight sealing. Mating surfaces shall be designed to provide watertight seals when metal to metal contact is made resulting in controlled O–ring compression without special torque requirements. No secondary sealing compounds, rectangular gaskets, elliptical O–rings, grease or other devices shall be used as a means of sealing.

L. Motor

1. The multi–pole motor shall be directly connected to the propeller (gearbox designs are not acceptable).

2. The motor shall have a minimum 1.1 service factor, a minimum of 30 feet of power and control cable, be of the squirrel–cage, induction, shell type NEMA B design, housed in an air-filled watertight chamber.

3. Stator winding and leads shall be insulated with moisture resistant Class F insulation, or better, which will resist a temperature of 155 °C (311 °F).

4. The stator shall be dipped and baked three times in Class F varnish.

5. The motor shall be designed for continuous duty, capable of sustaining 10 evenly spaced starts per hour.

6. The rotor bars and short circuit rings shall be constructed of aluminum.

M. Thermal Protection

1. Each phase of the motor shall contain a bi–metallic temperature monitor in the upper portion of the stator windings to monitor stator temperatures. The temperature monitors shall be imbedded in the stator winding coils, connected in series and coupled to the motor contactor coil providing single switch shutdown capability.

2. The temperature setting shall be a minimum of 260 °F and will automatically reset once the stator temperature returns to normal.

3. Temperature monitors shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

N. Moisture Sensor

1. Each mixer shall be equipped with an electrical probe to detect the presence of moisture in the oil chamber before bearing and motor damage occurs.

2. The moisture detection probe will provide the capability for remote monitoring of the state of the moisture probe either by monitoring a dry contact or through the generation of a 24 VAC or 120 VAC discrete signal.

O. Galvanic Corrosion Protection

1. When necessary to prevent galvanic corrosion, the mixer guide bracket shall have a chemical and abrasion resistant polyurethane liner and guide rollers preventing metal to metal contact between the guide bracket and the mounting and support system. Also, a polyurethane bushing shall be provided between the lifting cable shackle and the lifting clamp. The chemical and abrasion resistant liner, rollers and bushing are to provide galvanic corrosion protection by completely separating the mixer from the mounting system.

2.02 MOUNTING AND SUPPORT SYSTEM

A. Power Cable Support

1. A 30–feet–long, ¼–inch diameter, 304 or 316 stainless steel power cable support cable shall be provided with each mixer and be permanently attached to the mixer shackle on one end and the upper guide bracket of the mounting system on the other end. The power cable shall be attached to the support cable using sway clamps at a minimum of five–foot intervals.

B. Lifting Cable

1. A 30–feet–long, ¼–inch diameter, 304 or 316 stainless steel lifting cable shall be provided and attached to the lifting clamp shackle on the mixer. A cable cleat shall be provided to store the cable when needed.

C. Mounting System

1. A mounting system shall be supplied by the mixer manufacturer and used to mount the mixer and guide it during installation and removal without entering or emptying the tank. The upper guide bracket shall have a positioning locking plate and locking pin that securely positions the guide rail system at any position within a 150–degree arc in 15–degree increments without entering or emptying the tank. The mixer shall rest on a stop near the bottom of the tank preventing the mixer blades from contacting the tank floor. A 304–stainless steel mast system shall be used to guide and securely hold the mixer in place and be designed to

withstand the maximum loads produced by the mixer. The mast shall interface with the guide brackets to guide the mixer securely into position.

2. To ensure the integrity of the mounting system the mixer manufacturer shall supply the support guide brackets. The mast may be is supplied by others.

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The following inspections shall be performed as a routine quality check on each mixer prior to shipment from the factory.

1. Propeller size, motor rating, voltage, phase and frequency shall be checked for compliance with purchase order and specifications.

2. Motor and power cable shall be checked before submergence for insulation damage and the presence of moisture.

3. Pressurize the motor with dry air check for leaks at joints and seals.

4. Before submergence run the mixer to check for correct rotation and ensure mechanical integrity.

5. The mixer shall be submerged in a tank containing water and run completely submerged to check amp readings under load.

6. Motor and power cable shall be checked after submergence for insulation damage and the presence of moisture after removing the mixer from the tank.

B. A quality control check sheet showing that the above testing procedure has been performed and that the mixer successfully passed the tests shall be completed. The quality control check sheet shall be supplied with the final documents.

3.02 EXAMINATION

A. Contractor shall off–load equipment at installation site using equipment of sufficient size and design to prevent injury or damage. Immediately after off–loading, contractor shall inspect complete pump and appurtenances for shipping damage or missing parts. Any damage or discrepancy shall be noted in written claim with shipper prior to accepting delivery. Validate all serial numbers and parts lists with shipping documentation. Notify the manufacturer's representative of any unacceptable conditions noted with shipper.

3.03 INSTALLATION

A. Install, align, and lubricate pump(s) as indicated on project drawings. Installation must be in accordance with written instructions supplied by the manufacture at time of delivery.

3.04 FIELD QUALITY CONTROL

A. Contractor is to inspect the installed mixers(s) for visual deficiencies

B. Prior to acceptance by owner, an operational test of all mixers and control systems shall be conducted to determine if the installed equipment meets the purpose and intent of the specifications. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

3.05 PROTECTION

A. The contractor shall be responsible for provisions to protect the mixers and materials after installation but prior to acceptance by the Owner. Protection of the equipment shall include provisions during installation and testing of nearby piping, valving, or other adjacent equipment. The Contractor shall remove all protective measures installed at completion and acceptance of the project.

END OF SECTION

INDEX TO

SECTION 44 42 56 – PLANT REUSE WATER PUMP STATION

Paragraph	**Title**	**Page**

PART 3 – EXECUTION

SECTION 44 42 56

PLANT REUSE WATER SYSTEM

PART 1: GENERAL

1.1 SCOPE

To provide a single source responsibility for the manufacture, warranty, service and operation of a prefabricated, skid mounted, fully automatic pumping system for potable water.

A. Pumping system shall conform to the following specifications in all respects.

B. This specification covers minimum requirements; however, it should not be construed as all inclusive.

C. It is the successful vendor's responsibility to include everything necessary to provide a complete, automatic, smooth operating, and reliable pumping system.

D. The manufacturer shall warrant all items supplied by him, whether of his manufacture or of his purchase, per the warranty requirements below.

1. Pass through warranties, warranties provided by manufacturers of purchased equipment included in the pump station, passed through to the owner, shall not be accepted.
2. Pumping system manufacturer shall have a history, covering at least five years, of providing warranties of a single source responsibility nature.
3. On request, pumping system manufacturer shall provide contact information for pumping systems in which the manufacturer has provided this single source responsibility.

E. Manufacturer shall be a US manufacturer, and system shall be manufactured in the USA. All imported pumping systems or pumping systems from foreign manufacturers shall be rejected.

1.2 RELATED SECTIONS

A. Section 01 31 00 - Administrative procedures for start–up, testing and field–testing.

B. Section 33 10 00 Water Utilities

C. Section 25 50 00 – SCADA & Telemetry control systems

E. Section 09 90 00 – Painting

1.3 MANUFACTURER

A. The pumping system shall be model **SFIMC2– 2P360–VTP85**, as manufactured by SyncroFlo, Inc., Norcross, Georgia, U.S.A., as basis of design, operating on **460**–volt **3** phase **60** hertz power. Alternate manufacturer seeking authorization to bid shall be a registered ISO9001:2008 manufacturer, shall hold a current Quality Management Certificate, for the assembly of custom packaged pumping systems accessories and controls for use in commercial, irrigation, municipal, industrial and fire applications.

B. All bids shall be submitted using the SyncroFlo system as base bid. Those bids not using the SyncroFlo system as their base bid will be rejected as non–responsive.

C. For a proposed alternate pumping system to be considered as a post–bid deduct system, the contractor shall furnish the following data in the form of a qualification submittal, in three bound copies with each copy bound as a single document complete with detailed table of contents, and two CDs with the same data in Adobe Acrobat format, to the engineer at least 15 days prior to the date of the bid opening. Qualification submittal shall have been prepared specifically for this project and shall not be a "typical" document that may apply to a number of systems. Qualification submittal shall include a title page stating: project name, project number, owner's name, engineer's name, submitting party's name and contact information, date of submittal, and bid date. Qualification submittal shall include, as a minimum, the following:

1. A complete specification for the pumping system proposed as an equal, including operating sequence, alarm sequence, and bill of materials.
2. A statement of full conformance to the following specifications, including the supplying of the brands of products listed, and to the plans. Statement shall be signed by an officer of the manufacturing firm, and signature shall be notarized.
3. Complete submittal data for all major equipment, as listed in this specification, including properly indicated pump curves.
4. An electrical schematic showing power and control wiring.
5. Complete PLC program listing, properly annotated.
6. Installation list of 20 similar pumping systems which have been in operation for a minimum of 3 years.
7. Location and contact information of closest factory owned and/or trained service centers and date of last factory training session.
8. In order to assure that the manufacturer submitting for pre–approval has in place an acceptable quality assurance program, the manufacturer shall submit copies of their ISO9001:2008 Certificate of Registration, their UL authorization, and their ETL authorization as a part of the qualification submittal.
9. A copy of manufacturer's certificate of insurance showing as a minimum, a general liability coverage of $1,000,000, and an excess liability coverage of $10,000,000.
10. In order to assure that all welding will be accomplished according to ASME standards, copies of all fabricating employees' ASME Section IX pressure vessel certification and AWS D1.1 structural certification shall be included in the qualification submittal.
11. A listing of service department employees authorized for system commissioning and start up, including employee's name and employee number, years of experience starting systems as an employee of the submitting company, contact information, and employee's supervisor's name and contact information.

D. Only if, in the sole opinion of the engineer, the data submitted shows the pumping system to be an acceptable alternate deduct system, shall the bidding contractor be notified not less than 3 days prior to the bid opening date of acceptance of the submitted equipment as an alternate deduct to the base bid.

E. All bids shall be submitted using the SyncroFlo system as basis of design. Alternate manufacturer, whose pumping system has been preapproved as an alternate deduct, shall be included by addendum as an alternate deduct to the base bid system.

F. Approval of a qualification submittal does not relieve the manufacturer or supplier form providing full and complete submittals if their system is selected, nor does it relieve them of having to conform to these specifications and plans in all respects.

G. Any bids for equipment not previously pre–approved shall be considered as non–responsive and rejected.

H. Requests for substitution of major equipment brand, size, type or function shall be made in writing prior to preparation of the qualification submittal and shall only be included in the submittal and the qualification submittal if previously approved. Otherwise, major equipment shall be as specified in brand, size, type and function as described herein and on the plans. In no wise shall the substitution of the approved alternate piece of major equipment cause the price of the pumping system to increase; however, a significant decrease in price shall be expected and required due to the substitution.

1.4 SUBMITTALS

Within four weeks from award of contract, provide six copies of the submittal for approval, properly dated, sectioned, bound, titled, with a detailed table of contents, including no less than the following:

A. Full set of mechanical drawings including skid dimensioning, connection dimensions, anchor bolt location and typical installation, and equipment layout, all to scale

B. Full electrical schematic, including three–line power schematic, control ladder logic, PLC and SCADA system interface.

C. In order to assure that all welding will be accomplished according to ASME standards, submit copies of all fabricating employees' ASME Section IX pressure vessel certification and AWS D1.1 structural certification. Only those employees with said welding certificates submitted shall weld on the structural or piping portions of the system.

D. Properly indicated pump curves, whose total dynamic head includes pumping system internal losses, manufacturer's name (other than pumping system manufacturer), pump model number, and motor type, RPM and horsepower.

E. Properly marked cut sheets for each major component of the pumping system, both mechanical and electrical.

F. Copies of UL and ETL authorizations for control panels, and for complete pumping system.

G. Manufacturer's current ISO9001:2008 certificate.

H. Complete description of the system including:

1. Submittal schedule,
2. Shipment schedule after receipt of approved submittals,

3. Specification section number relevant to the submittal,
4. Technical information
    a. system model number,
    b. design GPM,
    c. rated suction pressure or lift,
    d. rated discharge pressure,
    e. voltage phase and frequency of required power,
    f. system approximate dry weight
5. Operation sequence,
6. Alarm sequence,
7. Mechanical major component bill of materials,
8. Electrical major component bill of materials,
9. Spare parts list,
10. SCADA interface (if required),
11. Post production features,
12. Notes clarification and exceptions,
13. Receiving instructions,
14. Storage instructions
15. Warranty statement

1.5 OWNER'S MANUALS

A. Operation and maintenance manual shall be provided in two copies to the contractor.

B. Operation and maintenance manual shall have been prepared for this specific project and shall not be a general manual applicable to many systems. Manufacturers' technical manuals shall be included for each piece of equipment that is field serviceable.

C. Manuals shall include the approved submittal and shall be produced in the same format as the submittal, bound in a three–ring binder, with tabbed sections.

D. Manufacturer's manuals shall be included after the submittal pages for each field serviceable device.

E. Components that are serviceable through replacement only shall not have any manuals included. Such components shall include, but shall not necessarily be limited to:

1. Flexible pipe couplings
2. Relays
3. Pressure transducers
4. Pressure switches
5. PLC components

1.6 REFERENCES

A. American Water Works Association (AWWA)

B. American National Standards (ANSI)

C. American Standards for Testing Materials (ASTM)

D. Hydraulic Institute

E. American Society of Mechanical Engineers (ASME)

1.7 CODES

A. Without exception, pumping system shall be UL and ETL listed as finally assembled.

B. Control panel with controls shall be built in accordance to NEC, and U.L and ETL. standards.

1. Without exception, the electrical components and enclosure shall be labeled as a complete U.L. and ETL listed industrial control panel assembly.

2. Manufacturer's U.L. and ETL labels shall be applied to the door.

C. Without exception, pumping system shall be manufactured under the manufacturer's ISO9001:2008 quality assurance program.

1.8 SEQUENCE OF OPERATION

A. General items applying to each alarm circuit shall include a display of condition, the illumination of a red indicating light, and manual or automatic reset of condition.

B. Alarm sequence

1. Low Water Level Alarm. Low water level alarm shall serve to protect the pumps from the adverse effects of running dry. Alarm shall be activated when level in the supply reservoir reaches a critical low level. Alarm shall cause the pumps to be retired in an orderly manner. Alarm shall not be capable of being overridden. Alarm shall not allow any pumps to run, whether in the "Hand" or "Automatic" functions of the selector switch until level has been restored and alarm has been reset. Indication of the alarm shall be displayed visually on the control panel door. Alarm shall be equipped with visual indication and automatic reset.

2. High Discharge Pressure Alarm. High Discharge Pressure alarm circuit shall shut down pumping system if discharge pressure reaches a predetermined high level. Operator interface device (OIT), mounted in enclosure door, shall signal high discharge pressure. Pumping system shall not operate until pressure is reduced and alarm has been reset. Alarm shall be equipped with visual indication and automatic reset.

3. Low Discharge Pressure alarm. Low Discharge Pressure alarm circuit shall shut down pumping system in the event discharge pressure drops below normal level. Operator interface device (OIT), mounted in enclosure door, shall signal low discharge pressure. Pumping system shall operate until

alarm has been manually reset. Alarm shall be equipped with visual indication and manual override.

4. Main phase failure and low voltage safety circuit shall retire the pumping system if it experiences low voltage, phase failure or phase reversal as monitored at line–side of control enclosure. Phase monitor shall have a time delay to allow for transient low voltage during motor starting and to allow maximum motor protection Operator interface device (OIT), mounted in enclosure door, shall signal phase failure for any affected pump.
5. Pump or VFD Failure Alarm. Pump or VFD Failure alarm circuit shall shut down its individual pump and VFD if the VFD detects an overload condition or if the VFD experiences an internal fault. Alarm shall be equipped with visual indication.
6. Plugged Strainer Alarm. Plugged strainer alarm shall shut down pumping system if it experiences a high differential pressure across the automatic and or wye strainers. Alarm shall be able to be reset manually after screen(s) have been cleaned and differential pressure falls below the set–point.

C. Functional Sequence, Pressure and Flow Sequencing

1. Equal sized pumps shall be alternated based on accumulated run time, the pump having the least run time starting as lead.
2. In the event a pump has failed to run or start, or if its switch is turned off, PLC shall shift the pumping sequence to utilize the remaining pumps. Only one pump shall run at a time.
3. Designated pump shall start immediately on a reduction in discharge pressure (10 psid factory default value).
4. PLC shall control pump's VFD to maintain discharge pressure regardless of flow rate.
5. Designated pump shall retire when flow has decreased to zero as maintained for a time (30–45 seconds default value).

1.9 CONTROLS REQUIREMENTS

A. All control enclosures and controls shall have been manufactured on the pumping system manufacturer's site by the pumping system manufacturer.

B. In order to assure complete system integration, Manufacturer, without exception, shall maintain a fully equipped UL and ETL authorized panel shop at his facility under the same roof as the fabrication, painting, and assembly of the mechanical components.

C. Manufacturer, without exception, shall be authorized by Underwriters' Laboratories to label its manufactured control panels as UL Listed under category NITW/NITW7.

D. Manufacturer, without exception, shall conform to the latest edition of NFPA 70 in the manufacturing of its control panels.

E. Manufacturers not conforming fully to these requirements shall have their bids rejected as non–responsive.

PART 2 PRODUCTS

2.1 VERTICAL TURBINE PUMPS

A. Vertical turbine type pumps shall be supplied. The vertical turbine pumps shall be manufactured according to the standards of the Hydraulic Institute and to ANSI specification No. B58.1. Bowl assembly, column pipe, line–shaft, head shaft, and discharge head shall be of U.S. manufacture. The pumping systems manufacturer shall have a network of service centers which shall have available spare parts and trained pump technicians to handle service, repair and warranty procedures.

B. The cast iron discharge head shall have a minimum tensile strength of 30,000 PSI. Pump discharge head shall have a working pressure of not less than 175 PSI and its discharge flange shall conform to ANSI 150 bolt pattern standards. Complete discharge head shall be hydrostatically tested at 200 PSI or greater.

C. A product lubricated high–pressure stuffing box containing a mechanical seal shall be provided. The discharge head stuffing box area shall also include an atmospheric drain port which will be piped off skid. Stuffing box bushing shall be from bearing bronze.

D. The head shaft shall be of the two–piece type, 416 stainless steel and shall be turned and ground. The pump manufacturer shall include a method for adjusting the impeller running clearance at the top of the head shaft. Adequate space shall exist to couple the head shaft and the line shaft above the stuffing box. Coupling shall be extra heavy duty AISI 416 SS.

E. Column pipe should be A53, Grade B schedule 40 material, in inter–changeable sections not more than 5 feet in length. Pump line shaft shall be AISI 416 SS. The size of the shaft shall be no less than determined by ANSI specification B58.1, Section 4.2, Table 4. Bearing retainers shall be bronze with rubber bearings.

F. The pump bowls shall be ASTM A48 Class 30 cast iron free of detrimental defects, glass lined.

G. The enclosed impellers shall be from C83800 bronze. Semi–open type impellers shall not be accepted. Pump shaft shall be AISI 416 SS turned and ground. The shaft shall be supported by bronze bearings above and below each impeller. The suction bell bearing shall be permanently grease packed and sealed with a sand collar.

H. A stainless-steel clip-on type inlet strainer shall be mounted on the bottom of each pump. Inlet area shall not be less than 4 times the suction bell inlet area.

I. For vertical turbine pumps to be operated on VFD, pump submittal shall include calculations showing critical speed calculations for the pumps, and that the line shaft bearing spacing is determined to avoid that critical speed throughout the expected range of pump speed on the VFD.

J. Pump bowl assemblies shall be as manufactured by Peerless.

K. Each pump shall be factory wet pit tested prior to shipment from the pump manufacturer's facility. Shop tests shall prove conclusively that the characteristics of each pump with respect to pressure, duty, capacity, rating, efficiency, performance, function, or special requirements as specified herein comply fully with requirements specified herein and that each pump will operate in the manner specified or implied.

L. Conditions of service:

- Pumping System Estimated Lift: **18'** water column
- Pumping System Estimated Internal Losses: **15'** water column
- Pumping System Discharge Pressure: **85** PSIG

Pump No.	Duty Point	Pump TDH	% Efficiency	Horsepower	RPM
1	400 GPM	230'	84%	40	1800
2	400 GPM	230'	84%	40	1800

2.2 VERTICAL HOLLOW–SHAFT MOTORS:

A. Motors for main pumps shall be high thrust vertical hollow shaft design, WP–I enclosed, shall have a 1.0 service factor when used with PWM, and a 1.15 service factor when used with a sine wave drive, and shall have class F insulation.

B. Motors shall be wound for full voltage starting and shall be suitable for use with a variable frequency drive, conforming to MG1 Part 31.

C. Each motor shall include a steady bushing to be installed around the pump head shaft, set against the hollow shaft of the motor, and securely attached to the head shaft. Installation and attachment shall occur at the time of pump and motor installation.

D. For pump lengths over 20 feet, each motor shall be equipped with a non–reverse ratchet assembly to prevent counter rotation and possible damage to pump components.

E. Maximum pump run out horsepower shall not be greater than motor nameplate rating exclusive of service factor.

F. Motor shall be rated for continuous duty and be designed to carry the maximum thrust load of the pump.

G. Without exception, motors shall be as manufactured by GE or U.S. Electrical Motors.

2.3 AIR VACUUM VALVE

A. Each pump head shall be equipped with a 1" air vacuum valve and isolating ball valve.

B. Valve shall include a stainless–steel float and full-sized orifice.

C. Valve shall be rated at 150 psi working pressure.

D. Valves shall be mounted on the port of the vertical turbine pump head.

E. Air release valve shall be as manufactured by Val–Matic.

2.4 AWWA C504 BUTTERFLY ISOLATION VALVES

A. All isolation valves 3" and larger shall be provided as shown on the contract drawings.

B. Valve shall be manufactured in accordance with the latest revision of AWWA C504, Class 150B (and/or 250B as required) and shall conform to NSF Standard 61.

C. Valve shall be sized for a maximum velocity of 7 fps.

D. Valve shall have one–piece body cast from ASTM A126 Class B cast iron.

E. Stem shall be 304 stainless steel.

F. Disc shall be from ASTM A126 Class B cast iron with a 316–stainless steel edge, lens shaped design, retained by stainless steel pins extending through the stem.

G. Stem bushings shall be self-lubricating non–metallic material.

H. Seat shall be one–piece elastomer, bonded into a recessed cavity in the valve body.

I. Manual actuator shall be of the traveling nut, self locking type and shall be designed to hold the valve in any position intermediate between fully open and fully closed without creeping or fluttering.

J. Valve shall be rated at 150 PSI working pressure.

K. Pump suction isolation valve shall be model 2000 as manufactured by Val–Matic or model 2FII as manufactured by Henry Pratt Company.

2.5 LUG PATTERN BUTTERFLY ISOLATION VALVE

A. Isolation valves in 2 and 2.5" sizes shall be of the lug style butterfly type.

B. Valve shall have one–piece body cast from ASTM A–126 Class B cast iron.

C. Stem shall be from 416 stainless steel.

D. Disc shall be from ASTM A–395; Aluminum Bronze.

E. Stem bushings shall be Duralon to prevent stem seizure to body during prolonged periods of non–use. Stem O–ring shall be from Buna–N.

F. Seat shall be from EPDM elastomer, one–piece construction, and shall also form the flange sealing gaskets.

G. Valves 6" and smaller shall have a lever operator.

H. Valves 8" and larger shall have a gear operator with hand wheel.

I. Valve shall be rated at 200 PSI bubble shutoff.

J. Valve shall be model 31H as manufactured by Bray.

2.6 BALL VALVES

A. Isolation valves shall be provided as full port ball valves in sizes 1.5" and smaller.

B. Valve shall be a two–piece bronze full port ball valve.

C. Valve shall be sized for a maximum velocity of 7 fps.

D. Valve shall have adjustable packing, blow–out proof stem, RPTFE seats and stuffing box ring, hardened ball, and actuator mounting pad.

E. Stem and gland shall be from B16 bronze.

F. Ball shall be chrome plated, from B16 bronze.

G. Retainer and body shall be from B584–C84400 bronze.

H. Body seal shall be from PTFE.

I. Quarter turn manual actuator shall be from zinc plated steel, with Vinyl cover.

J. Valve shall be rated at 600 PSI CWP.

K. Pump isolation valve shall be Apollo model 77–100 as manufactured by Conbraco.

2.7 VIBRATION ISOLATION

A. Flexible Pipe Connectors.

1. Each pump discharge connection shall include a grooved flexible connector, single sphere type, rated at a minimum of 300 psi maximum working pressure for connector sizes through 12".
2. Both wetted and non-wetted elastomeric portions of the flexible connector shall be as manufactured from EPDM.
3. Connectors shall be installed between each pump check valve and its isolation valve.

2.8 CHECK VALVE

Pump check valve shall be provided on the discharge of each pump. Filter check valve shall be provided on the discharge of the automatic filter. Check valve shall be of the silent type. Check valves shall begin to close as forward velocity diminishes and shall be fully closed at zero velocity preventing flow reversal.

A. Valve bodies shall be cast from CAST IRON ASTM A126, CLASS B and shall be free from blow holes, sand holes, and other impurities.

B. Seat shall be as manufactured from BRONZE ASTM B584, ALLOY C83600 and have a Buna–N insert for positive sealing to the disc.

C. Disc shall be as manufactured from BRONZE ASTM B584, ALLOY C83600.

C. Spring shall be as manufactured from STAINLESS STEEL T316, ASTM A313.

D. Bushing shall be as manufactured from BRONZE ASTM B16, ALLOY C36000

E. Retaining screws shall be as manufactured from STAINLESS STEEL T316, ASTM F879.

F. The valve design shall incorporate a center guided, spring loaded poppet, guided at opposite ends, having a short linear stroke that generates a flow area equal to the pipe diameter.

G. Valves shall be sized to permit full pump capacity to discharge through them without exceeding a pressure drop of 6 feet of water column.

H. Check valves through 10" shall be from series 1400BN rated at 400 psi working pressure.

I. Check valves greater than 10" shall be from series 1800BN rated at 200 psi working pressure.

J. Check valves shall be as manufactured by Val–Matic.

2.9 PRESSURE RELIEF VALVE.

A. Pressure relief valve shall be single–seated, diaphragm operated, pilot–controlled, globe or angle valve. It shall be spring loaded & hydraulically operated. Valve spring shall be of stainless steel. Seat ring shall be of stainless steel & readily replaceable with no special tools.

B. Diaphragm assembly shall be fully guided, top and bottom. Diaphragm shall be of nylon reinforced Buna–N synthetic rubber and shall be fully supported by the valve casting in both the full–open and full–closed positions to eliminate strain on the diaphragm. All necessary repairs shall be possible without removing valve from the line. Packing glands are not permitted. Disc shall be synthetic rubber (Buna–N) and have a rectangular cross section. Valve disc and seat shall have an anti–cavitation design of intermeshing orifices to prevent cavitation from discharge pressure to atmosphere.

C. The main valve shall be equipped with the following accessories to ensure proper operation.

1. All control valve pilots shall have stainless steel seats, Buna–N sealing surface and a Buna–N diaphragm. Pilot valve bodies shall be from bronze.

2. Pressure–sustaining pilot shall be sensitive to valve inlet pressure. Pilot shall be normally closed and spring–loaded with spring tension adjustment. Pilot shall open automatically against the spring–loading set when pilot inlet pressure exceeds the set value. This pilot shall function to maintain a minimum valve inlet pressure which shall prevent the pumps from operating under an unstable or overloaded condition.

3. Isolation cocks shall be provided on control tubing at the valve inlet, outlet and bonnet ports on valves 4" and larger. These valves shall be situated such that the control valve may be manually closed & the valve trim isolated and serviced.

4. Strainers shall be provided to remove any solids that may be of sufficient size to damage or plug the pilots and other control components. The inner mesh shall be of MONEL and shall be designed to support the outer screen. The outer screen shall be of 0.008" MONEL wire, having a 40 x 40 mesh.

D. An isolation valve shall be provided at the inlet of the surge anticipator valve, conforming to the requirements of the high–pressure butterfly pump isolation valves specification.

E. Valve may exhaust to atmosphere, or to a or to suction manifold, per the plans.

F. Valve shall be a model 50G–01A as manufactured by Cla–Val Company of Newport Beach, CA.

2.10 SELF–CLEANING FILTER, SAF

Pumping system discharge shall include an automatic self–cleaning SAF filter, as manufactured by Amiad.

A. The SAF filter shall start the self–cleaning process when the pressure differential across the screen reaches a pre–set value or a pre–determined lapse of time. Cleaning of the filter's fine screen shall be carried out by the suction scanner which shall rotate in a spiral motion while vacuuming the filter cake from the screen and expelling it out through the exhaust valve. During the self-cleaning process, filtered water shall continue to flow downstream.

B. Two types of control boards shall be available for the SAF filters: PLC and Relay.

C. Features:

- Flush according to pressure differential and/or according to time.
- Flush counter.
- Operate an alarm or an alternative malfunction mode indicator

D. Filtration Element: Filter shall include a four-layer, "floating" screen technology. The filter shall offer an effective filtration area than competitive filters which improves their ability to trap and sustain suspended solids, extends the duration between flush intervals, improves back flush efficiency, and overall increase the filters' long-term durability.

E. Cleaning Mechanism: The SAF Suction Scanner cleaning mechanism offers the highest back flush velocity per square inch of any available filter on the market. This superior performance ensures the filter element will be 100 percent clean following each flush with a minimal waste of water.

F. Low Maintenance: The SAF series streamlined automatic, self-cleaning design lowers filter operator maintenance time and cost and provides a simple-to-follow maintenance plan.

G. Customer Support: With more than 40 years of experience in designing, manufacturing and distributing global water filtration systems, Amiad offers customers an unprecedented sales and technical knowledge base. Additionally, its network of sales and technical representatives located throughout North America, guarantees customers timely responses and personal attention.

H. Technical characteristics:

1. Maximum flow rate – 660 GPM
2. Minimum operating pressure – 30 PSI
3. Maximum working pressure – 150 PSI
4. Maximum working temperature – 140°F
5. Flush Reject Volume of filter – 17 Gal
6. Flush cycle – 20 sec.
7. Flush Flow – 48 GPM @ 30 PSI
8. Filter mesh – 200 µ

I. Filter shall include a wafer pattern silent check valve on its outlet and an isolation valve at its inlet and shall include a 460/3/60 control panel.

2.11 WYE STRAINER

A. Pumping system shall include a skid mounted wye strainer, with isolation valves and flex connector, in parallel with the filter.

B. Strainer shall be 6" ANSI 125 flanged and shall be rated at a pressure drop of 0.3 PSI at rated system capacity. Max working pressure shall be 200 PSIG.

C. All parts of the wye strainer shall be accessible for service without removing the strainer from the line.

D. Wye strainer shall include a 60–mesh stainless steel basket.

E. Basket access shall be through a flanged cover, bolted in place.

F. Wye strainer shall be as manufactured by Watts.

2.12 SAMPLE TAP

Sample tap shall be installed with a vacuum breaker to prevent the possibility of cross contamination.

2.13 HOSE BIBB

Hose Bibb shall be installed with a vacuum breaker to prevent the possibility of cross contamination.

2.14 WELDER QUALIFICATION

A. Welders performing structural and pipe welds shall be certified to ASME section IX, and their certificates shall be on file with the manufacturer. Upon request by the engineer or owner, the certificates shall be made available for inspection.

B. All employees welding structural members shall have certificates on file exhibiting conformance to ASME AWS D1.1 structural welding.

c. All equipment including, but not limited to, pumps, motors, valves, instrumentation and controls, shall be mounted on a common structural steel base to form a complete operating pumping system.

D. The pumping system base shall be designed and fabricated to provide proper structural support for all attached equipment if it is supported solely on the peripheral members. Internal members need not contact the floor. This design shall allow the pumping system to be mounted on a slab, a frost wall, or a basement foundation. The base shall supply sufficient rigidity to withstand the stresses of reasonable and competent transportation to site, off loading, installation, and operation.

E. Peripheral structural members shall be from channel or wide flange beam, ASTM A36.

F. Internal structural members shall be from ASTM A36 rectangular tubing or channel.

G. Base shall be of open framework construction, suitable for grouting.

H. All employees welding structural members shall have certificates on file exhibiting conformance to ASME AWS D1.1 structural welding.

I. Provisions shall be made in the station base for off–loading and handling the station at the site.

2.15 STAINLESS STEEL PIPING, 304SS

A. All piping shall be constructed from AISI 304 schedule 40 stainless steel pipe or heavier as required to maintain a 3 to 1 pressure safety factor.

B. Welders performing structural and pipe welds shall be certified to ASME section IX, and their certificates shall be on file with the manufacturer. Upon request by the engineer or owner, the certificates shall be made available for inspection.

C. All piping shall be hydrostatically tested at 150% of maximum shutoff pressure.

2.16 PIPING SUPPORT

A. Piping support shall be manufactured from structural rectangular tubing, sized according to the weight and size of the piping to be supported.

B. Each tubing member shall be capped to prevent internal corrosion.

C. Vertical tubing members shall be solidly welded to the skid and shall support the weight of the piping when filled with water.

D. Horizontal tubing members shall be solidly welded to the vertical members, shall extend beyond the pipe OD, and shall support the weight of the piping when filled with water.

E. Piping shall be secured to the members through the use of piping U bolts designed for this purpose.

F. Thrust of the piping, whether the thrust is in the vertical or horizontal direction, shall be restrained on site by the installing contractor.

2.17 PRESSURE GAUGES

A. A pressure gauge shall be mounted on the discharge header and on the filter discharge, complete with isolation ball valve.

B. Each gauge shall be filled to reduce wear due to vibration.

C. Gauge accuracy shall be within 0.5% and shall comply with ASME B40.1 Grade 2A.

D. Gauge diameter shall be 4.5" minimum.

E. Gauge materials of construction:

1. Connection and bourdon tube shall be from 316 stainless steel.
2. Movement shall be from stainless steel with an internal stop at 1.3 times the gauge range.
3. Dial shall be from white aluminum with black lettering and a stop at the 6 o'clock position.
4. Pointer shall be adjustable from black aluminum.
5. Turret style case shall be from black glass reinforced thermoplastic (PBTP), and shall have built in rear flange lugs, with a solid front and blow–out back, rated at NEMA 4X.
6. Window shall be from acrylic.
7. Window gasket shall be from Buna–N.
8. Filling material shall be glycerin.

F. Range shall be selected so that operating pressure is in the mid range of the gauge.

G. Gauge range shall in no case be less than 20% higher than the highest pressure attainable from the pumps at shutoff head conditions.

H. Gauge shall resist shocks to 100G.

I. Pressure gauge shall be model 233.34 as manufactured by Wika.

2.18 PRESSURE TRANSMITTER

A. Pressure Transmitter shall be mounted on the system discharge, downstream of the filters, and shall provide all pressure signals for the control logic.

B. Pressure Transmitter shall be supplied with an isolating ball valve.

C. Pressure Transmitter shall be a media isolated instrument, having no silicone oil, internal o–rings, or welds.

D. Pressure Transmitter wetted material shall be 17–4PH stainless steel NACE compatible housed in 304 stainless steel having a male threaded process connection.

E. Pressure Transmitter shall provide a 4–20 mA analog output linear with the sensed pressure, from a two wire 10–28 VDC supply, reverse polarity protected.

F. Pressure Transmitter shall have an accuracy of +/- 0.25% BFSL.

G. Resolution of the Transmitter shall be greater than the resolution of the analog to digital conversion for PLC operation.

H. Transmitter shall be rated for pressures greater than station discharge pressure, and shall provide gauge pressure output, rather than absolute pressure.

2.19 LEVEL SWITCH

A. Level switch shall be shipped loose for mounting in the supply sump and shall provide the low-level alarm signal.

B. Level switch shall be a submersible float switch, complete with weight and cable.

C. Transmitter shall be rated for a minimum of 0–30 feet of water column.

2.20 MAGNETIC FLOWMETER

The pumping system shall have a **4"** flow mag-meter installed, which shall be utilized for control and to display the pumping system flow rate, and to display total flow through the pumping system controller operator interface device (OIT). Flow meter shall be electro magnetic flow meter comprised of two major components, a primary head and a signal converter. Flow meter signal converter shall produce two separate signals, pulse and 4–20mA, in linear proportion to flow rate. Flow meter shall read flows from 0–40 fps, with a worst–case inaccuracy of 0.5% of indicated value (not a percentage of full scale) at 1.3 fps or greater. Flows less than 1.3 fps shall have a lower accuracy with accuracy applying to indicated value (not full scale). Flow meter shall be sized so that maximum system flow lies between 16 and 24 fps through the meter. Meter shall be installed according to manufacturer's recommendations. Manufacturer shall have a US based manufacturing and assembly center. Flow meter shall be as manufactured by **Siemens**, without exception.

A. Primary Head: The flow tube shall be a ANSI B16.5 class 150 flanged for sizes less than 24" and AWWA class D flanged for sizes above 24" with a 304SS spool. Wetted liner shall be hard rubber. Liner shall extend beyond the ends of the flow tube and over the flange faces. Liner shall remain stable and in place under a 500–mBar absolute vacuum or pressure situation. Liner shall be rated for the medium pumped. Magnetic coils shall be wound by the flow meter manufacturer and held in place in such a way as to prevent any fluctuation in the magnetic field generated. Magnetic coils in flow tubes 6" and smaller shall be epoxied together through a fusion bonding process, which renders the magnetic coil a single solid piece with no loose windings. Electrodes shall be from Hastelloy C4. They shall be inserted from the inside of the flow tube and shall be sealed along their length. Electrodes sealed at one or more discrete points shall not be accepted. The wires connecting the electrodes to the primary head shall be fastened in place along their entire length to prevent the transmission of erroneous data or signal noise acquired through signal wire movement. All wiring shall be brought into the primary head connection box and terminated. The shroud protecting the coils and electrodes shall be welded in place, and internally pressure tested to 1.5 atmospheres with air pressure. On completion, the flow tube shall be finish painted on all outside metallic surfaces. Primary head shall be NEMA 6 rated.

B. Signal Converter: The signal converter shall be NEMA 4X rated and shall house the microprocessor–based electronics required for magnet excitation and flow measurement. Functions and data requirements shall be set by either a PC or by a hand–held programmer. Unit shall process flow using a bipolar pulsed DC signal. Power supply shall be 115/230VAC 48–64 Hz. Outputs shall be 4–20 mA and pulsed output scalable at 0–100Hz or 0–1000 Hz for full scale range. Signal converter shall also include a binary output to indicate direction of flow.

C. Grounding rings: Where magnetic flow meters are placed in a pipeline that insulates the water from ground (e.g. epoxy lined steel pipe or plastic pipe) grounding rings are required at both ends of the flow meter to eliminate electrical eddy currents that may exist within the medium being pumped. Grounding rings and flow meter body must be grounded properly., in accordance with manufacturer's recommendations.

D. Calibration and Testing: Meter shall be hydraulically calibrated on a testing device that is at least 10 times more accurate than the meter and shall not be calibrated against a master meter. Each and every flow meter produced by the flow meter manufacturer shall be flow tested and hydraulically calibrated according to this procedure. Manufacturer's test and calibration equipment shall be internationally certified and shall be re–certified every three years. Calibration shall be accomplished through direct volumetric comparison, on rigs certified as having a measurement error of equal to or less than 0.03%. A calibration certificate shall be issued for each and every flow meter produced by the flow meter manufacturer. Calibration certificate shall be traceable to the US National Bureau of Standards. Meters shall be calibrated under standard conditions to a measurement error of less than 0.50% of rate.

E. Best resolution of flowmeter shall be with 5 diameters of straight pipe upstream of the center of the flowmeter, and 2 such diameters downstream of the center of the meter. In space critical situations, the meter manufacturer shall authorize the system manufacturer to attach 90–degree elbows directly to both flanges of the meter, without compromising the accuracy to more than 1% of indicated value (not full scale). Meter manufacturer shall have provided system manufacturer with a written authorization and test data, which shall be kept on file at the system manufacturer's place of business and made available for inspection on request.

F. Stainless steel grounding rings, properly bonded, shall be provided at the inlet and outlet of the flowmeter, when the piping is non–conductive, to arrest any electrical eddy currents in the water that could affect the meter accuracy.

2.21 PAINT

A. Structural steel and supports shall be cleaned then grit–blasted per SSPC–SP6 to commercial blast condition.

B. Primer shall be immediately applied and shall be a two-part epoxy primer.

C. Primer shall be PPG's EPX–900 applied in one coat to 4.0–6.0 mils WFT, or pre–approved equal.

D. Finish coat shall be applied after proper curing time for the primer.

E. Finish coat shall be PPG's AUE–300/301 applied in one coat to 2.7–4.0 mils WFT, or pre–approved equal.

F. Finish coat shall be irrigation green in color.

2.22 BOLTS

All bolts and nuts used in the assembly of the pumping system shall be zinc plated grade 5. As required in specific locations to protect the finish and prevent loosening, bolts shall be provided with washers and lock washers.

2.23 CONTROL ENCLOSURE, WITH AIR CONDITIONER

A. Controls shall be housed in a NEMA 4X **316 stainless steel** enclosure with integral latches.

B. The control enclosure shall be constructed of 14–gauge stainless steel and the back–plate assembly shall be constructed of 12-gauge steel.

C. All indicating lights, reset buttons, selector switches and the operator interface device (OIT) shall be mounted on enclosure door and shall be rated NEMA 4X.

D. All internal components shall be mounted and secured to the removable back plate assembly. All equipment and wiring shall be mounted within the enclosure and labeled for proper identification.

E. All adjustments and maintenance shall be able to be done from the front of the control enclosure.

F. A complete wiring circuit and legend with all terminals, components, and wiring identification shall be provided.

G. Enclosure and internally mounted equipment shall be cooled using a cabinet mounted air conditioner.

H. Air conditioner shall be rated NEMA 4X and shall not allow any air exchange from enclosure external air to internal air.

I. Air conditioner shall be sized to assure adequate removal of all heat with all electrical equipment operating at maximum demand.

2.24 LIGHTNING AND SURGE ARRESTOR

A. Electrical equipment shall be protected by a U.L. 1449 Third Edition Listed SPD to suppress voltage surges on incoming power.

B. SPD shall be connected to the line side of the pumping system landing lugs and shall be properly grounded.

C. The device shall be rated according to IEEE C62.41.1–2002, C62.41.2–2002, and C63.45–2002 to provide a surge capacity of no less than 50kA per phase.

D. Response time shall not be greater than 1 nanosecond.

E. SPD shall withstand no less than 5000 3kA impulses, 8x20µs, or 1000 10kA impulses, 8x20µs.

F. Manufacturer of SPD shall be ISO 9001:2000 certified and shall have an ISO 17025:2005 test lab.

2.25 CIRCUIT BREAKER MAIN DISCONNECT

A. A circuit breaker main disconnect shall be provided to isolate all controls and motor starting equipment from incoming power.

B. UL/CSA short–circuit interrupting capacity rating of the circuit breaker shall be not less than 25,000 amps.

C. Main disconnect shall have a through the door operator and shall be sized in accordance with current NFPA 70 and UL requirements.

D. Disconnect shall be as manufactured by Eaton or Schneider Electric.

E. Disconnect's short circuit rating shall not be less than 25,000 amps.

2.26 CONTROL POWER

A. Power for the controls shall be provided by a control power transformer which shall provide 120–volt, single phase power for the pumping system control operation.

B. Control power transformer shall not be used for any load other than controls.

C. The control power transformer shall be protected on the primary side by control limiting fuses of adequate size and voltage rating.

D. All control components on the load side of the transformer shall be protected by time delay circuit breakers of adequate size.

E. The control power transformer shall be as manufactured by Micron Industries or pre–approved equal.

2.27 CIRCUIT BREAKER VFD DISCONNECT

A. A circuit breaker disconnect shall be provided in the control panel to isolate each VFD from incoming power and provide short circuit protection.

B. UL/CSA short–circuit interrupting capacity rating of the circuit breaker shall be not less than 25,000 amps.

C. Disconnect shall be as manufactured by Eaton or Schneider Electric.

D. Disconnect's short circuit rating shall not be less than 25,000 amps.

2.28 VARIABLE FREQUENCY DRIVE

Variable frequency drives shall be Mitsubishi model F700, without exception.

A. The Drive shall be solid state, with a Pulse Width Modulated (PWM) output. The drive shall utilize the latest isolated gate bipolar transistor (IGBT) technology. VFD must include all of the following features.

B. Control Specifications:

1. Control System – selectable as high carrier frequency PWM control (V/F control), optimum excitation control, and simple magnetic flux vector control

2. Output frequency range – 0.5–400 Hz

3. Frequency Setting Resolution:

a. Voltage input: 0.015Hz from 0 to 60Hz for 0 to 10V =12bit resolution;

b. Voltage input: 0.03Hz from 0 to 60Hz 0 to 5V = 11bit resolution;

c. Milliamp input: 0 to 20mA at approximately 11bit resolution;

d. Voltage input: –10V to +10V = 11bit resolution;

e. Voltage input: 0 to ±5V = 10bit resolution.

f. Digital Input: 0.01Hz

4. Frequency accuracy:

a. Analog input: Within ±0.2% of the max. output frequency (25°C ± 10°C)

b. Digital Input: Within 0.01% of the set output frequency

5. Voltage/Frequency Characteristics: Base frequency can be set from 0 to 400Hz. Constant torque/variable torque pattern or adjustable 5 points V/F can be selected.

6. Starting Torque: 120% (3Hz) when set to simple magnetic flux vector control and slip compensation

7. Acceleration/Deceleration Time Setting: 0 to 3600s (acceleration and deceleration can be set individually), linear or S–pattern acceleration/deceleration mode can be selected

8. Stall Prevention Operation Level: Operation current level can be set (0 to 150% adjustable), whether to use the function or not can be selected

C. Operation Specifications:

1. Frequency Setting Signal:

a. Analog Input: 0 to 10V, 0 to 5V, 4 to 20mA, –10 to +10V, –5 to 5V can be selected.

b. Digital Input: Four–digit BCD or 16–bit binary using the setting dial of the operation panel (when used with the option FR–A7AX)

2. Start Signal: Available individually for forward and reverse rotation. Start signal automatic self–holding input (3–wire input) can be selected.

3. Operational Functions:

a. Maximum and minimum frequency settings,

b. Frequency jump operation,

c. External thermal relay input selection,

d. Polarity reversible operation,

e. Automatic restart after instantaneous power failure operation,

f. Continuous operation at an instantaneous power failure,

g. Commercial power supply–inverter switchover operation,

h. Forward/reverse rotation prevention,

i. Operation mode selection,

j. PID control,

k. Computer link operation (RS–485).

4. Output Signal Selection (Choose up to seven points, one point per function unless otherwise indicated):

a. Inverter running,

b. Up–to–speed,

c. Instantaneous power failure/undervoltage,

d. Overload warning, output frequency detection,

e. Second output frequency detection,

f. Electronic thermal relay function pre–alarm,

g. PU operation mode,

h. Inverter operation ready,

i. Output current detection,

j. Zero current detection,

k. PID lower limit,

l. PID upper limit,

m. PID forward rotation, reverse rotation output,

n. Commercial power supply–inverter switchover MC1,

0. Commercial power supply– inverter switchover MC2,

p. Commercial power supply–inverter switchover MC3,

q. Fan fault output,

r. Heat sink overheat pre–alarm,

s. Inverter running start command on,

t. Deceleration at an instantaneous power failure,

u. PID control activated,

v. During retry,

w. During pid output suspension,

x. Life alarm,

y. Input mc stop signal,

z. Power savings average value update timing,

aa. Current average monitor,

ab. Alarm output 2,

ac. Maintenance timer alarm,

ad. Remote output,

ae. Minor failure output,

af. Alarm output.

ag. Open collector output (5 points),

ah. Relay output (2 points)

ai. Alarm code of the inverter can be output (4 bit) from the open collector.

5. Pulse/Analog Output (select one of the following):

a. Output frequency,

b. Motor current (steady or peak value),

c. Output voltage,

d. Frequency setting value,

e. Running speed,

f. Converter output voltage (steady or peak value),

g. Electronic thermal relay function load factor,

h. Input power,

i. Output power,

j. Load meter,

k. Reference voltage output,

l. Motor load factor,

m. Energy saving effect,

n. PID set value,

o. PID process value, pulse train output

p. AM terminal function selection, analog output

D. Display Specifications:

1. Operating Status:

a. Output frequency,

b. Motor current (steady or peak value),

c. Output voltage,

d. Alarm indication,

e. Frequency setting,

f. Running speed,

g. Converter output voltage (steady or peak value),
h. Electronic thermal load factor,
i. Input voltage,
j. Output voltage,
k. Road meter,
l. Cumulative energization time,
m. Actual operation time,
n. Motor load factor,
o. Cumulative energization power,
p. Power saving effect,
q. Cumulative saving power,
r. PID set point,
s. PID process value,
t. PID deviation value,
u. Inverter I/O terminal monitor,

2. Alarms – displayed when the protective function is activated, and the output voltage/current/frequency/cumulative energization time right before the protection function was activated and the past 8 alarm definitions are selected to be stored.
3. Interactive Guidance – Operation guide and trouble shooting with a help function

E. Protective and Warning Functions:

1. Overcurrent during acceleration,
2. Overcurrent during constant speed,
3. Overcurrent during deceleration,
4. Overvoltage during acceleration,
5. Overvoltage during constant speed,
6. Overvoltage during deceleration,
7. Inverter protection thermal operation,
8. Heat sink overheat,
9. Instantaneous power failure occurrence,
10. Undervoltage,
11. Input phase failure,
12. Motor overload,
13. Output side ground fault overcurrent,
14. Output phase failure,
15. External thermal relay operation,

16. PTC thermistor operation,
17. Option alarm,
18. Parameter error,
19. PU disconnection,
20. Retry count excess,
21. CPU alarm,
22. Power supply short for operation panel,
23. 24vdc power output short,
24. Output current detection value over,
25. Inrush resistance overheat,
26. Communication alarm (inverter),
27. Analog input alarm,
28. Internal circuit alarm (15v power supply),
29. Fan fault,
30. Overcurrent stall prevention,
31. Overvoltage stall prevention,
32. Electronic thermal pre–alarm,
33. PU stop,
34. Maintenance timer alarm,
35. Parameter write error,
36. Copy operation error,
37. Operation panel lock.

F. Environment Requirements:

1. Ambient Temperature: –10°C to +50°C (non–freezing)
2. Ambient Humidity: 90% RH or less (non–condensing)
3. Storage temperature: –20°C to +65°C (applicable for a short period in transit, etc.)
4. Atmosphere: NEMA 1, Plenum rated – Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt, etc.)
5. Altitude: Maximum 1000 meters (3300 feet) MSL
6. Vibration: 5.9m/s^2 or less

G. Variable Torque Ratings: Three phase VFDs are to be derated by 40% for single phase input, three phase output operation. All Mitsubishi F700 VFDs rated for single phase input, three phase output operation have been tested and certified for use on single phase input power.

1. 240-volt, single phase, class: 1/2–75 hp, UL & cUL listed
2. 240-volt class: 1–200 hp at 200–240/3/60
3. 480-volt, single phase, class: 1/2–200 hp, UL & cUL listed

4. 480-volt class: 1–1000 hp at 380–480/3/60

H. Communications protocols:

1. Ethernet I/P
2. **Modbus TCP/IP**
3. BacNET I/P
4. Metasys N2
5. Siemens FLN
6. Modbus RTU
7. BacNET MSTP

I. Harmonics mitigation: Harmonic mitigation shall be in the form of a High Z 5%-line reactor connected between the VFD and its circuit breaker. Line reactor shall have no more than 80 watts heat rejection. Line reactor shall be installed in the control panel.

2.29 MICROPROCESSOR CONTROLS, VARIABLE SPEED

All control logic shall be handled by an industrial microprocessor logic controller accessible through a 7" high definition widescreen graphic operator interface which shall provide data entry and read-out capabilities. Controller shall provide demand controlled sequential pump start up, shutdown and alarm features through its pressure sensing, flow sensing and voltage sensing devices. Controller shall be provided with a built-in memory. Controller shall operate VFDs using dual PID loops, one for acceleration, and one for pressure maintenance. All logic for system control, and timing shall be handled by the controller.

A. Control software shall be parameter driven, fully documented, and allow user to easily change all operational parameters.

B. Conditions that shall be displayed on the controller's operator interface terminal (OIT):

1. Suction Pressure
2. Discharge pressure
3. Current flow rate
4. Total gallons pumped
5. Each alarm on its occurrence, retained until reset.
6. Each pump run time hours and tenths
7. Selection of manual or automatic alternation sequence.
8. Automatic or manual adjustment (selectable) of VFD speed, if pump H–O–A switches are in Auto.

C. Panel face switches and lights:

1. Individual pump run lights – Green LED
2. General alarm light – Red LED
3. Control power on light – White LED
3. Individual pump Hand/Off/Automatic switches

4 Alarm reset pushbutton.

D. All pumping system shutdowns shall be of the controlled type which sequence pumps off at user selectable intervals.

E. 7" high definition widescreen graphic operator interface shall be mounted on the control panel door.

1. This device shall allow the operator to view and modify each register in the PLC.
2. The device shall allow for display and modification of all timer values, set points, lockout times, etc.

F. PLC shall be MicroLogix 1400 as manufactured by Allen Bradley and shall be capable of Ethernet interface to a variety of SCADA platforms.

G. OIT shall be a Maple Systems HMI5070NH color touch screen. Screen shall be protected by a sunshield.

2.30 SCADA INTERFACE

A. SCADA system's connection shall be either hard wired or by Modbus TCP/IP connected to the dedicated terminal strip within the controls enclosure. SCADA connection shall be by the system integrator.

B. Set of auxiliary analog signals including:

1. Suction Pressure (AO)
2. Discharge Pressure (AO)
3. Flow Rate (AO)

C. Set of auxiliary contacts including:

1. Each Pump Call (DI)
2. Each Pump Running (DO)
3. Each Pump Fault (DO)
4. General Alarm (DO)

2.31 SPARE PARTS

A. Spare parts shall be provided as listed below, wrapped or bagged to prevent premature oxidation, and properly identified and boxed.

1. Qty (1) Seal kit with gaskets
2. Qty (1) Set of control panel replacement fuses
3. Qty (1) Set of pilot light replacement lamps

PART 3 EXECUTION

GENERAL.

Installing contractor shall be responsible for providing all materials, equipment, and labor necessary to install and connect the pumping system.

3.1 SYSTEM FACTORY WITNESSED FLOW TEST

The entire pumping system shall be flow tested across its entire range at the manufacturer's facility prior to shipment.

A. Factory flow test rig shall include flowmeter and gauges that are NIST traceable. Test rig shall be able to supply power to the pumping system control panel to support the operation of all pumps.

B. System shall be supplied with the established minimum suction pressure, and adequate flow for test of the pumps.

C. All electrical controls and circuits shall be included in the system test, as shall their interface to the motors and the outputs to the SCADA system.

D. System factory flow test results shall be provided in the form of an X–Y plot.

E. Any failure in the flow test, either for any pump or for the system, shall be corrected by the manufacturer at his expense, and the test repeated until satisfactory results are obtained.

F. Flow test may be witnessed in person. Advise engineer two weeks in advance of flow test to be witnessed in person. Transportation, lodging and per diem expenses shall be for the account of the person(s) witnessing the test in person.

G. Instead of a flow test being witnessed in person, a witness flow test shall be conducted virtually, via the internet, using a portable web cam. Test shall be interactive between the tester and the witness, allowing questions, comments and responses to be communicated while the test is in progress. Advise engineer one week in advance of flow test to be witnessed virtually.

H. Flow test shall be witnessed virtually, via the internet, using a portable web cam. Test shall be interactive between the tester and the witness, allowing questions, comments and responses to be communicated while the test is in progress. Advise engineer one week in advance of flow test to be witnessed virtually.

3.2 UNLOADING AND SETTING SUPERVISION

A. Setting of the pumping system and connection to suction, discharge and power, anchoring of the pumping system, and thrust blocking of the suction and discharge piping that is connected to the pumping system shall be the responsibility of the installing contractor and not the manufacturer.

B. Crane to off–load and set the pumping system onto the concrete slab shall be provided by installing contractor.

C. Manufacturer shall inform the contractor, prior to system shipment, of the calculated weight of the pumping system.

3.3 START UP

A. When discharge piping, electrical connections, and electrical inspection have been completed, the pumping system manufacturer shall be contacted for start up.

B. A minimum one-week notice shall be given to manufacturer prior to scheduled start up date.

C. Field testing:

1. During start up, the complete pumping system shall be inspected for proper installation and shall be given a running test of normal start and stop, and fully loaded operating conditions.

2. During this test, each pump shall demonstrate its ability to operate without undue vibration or overheating and shall demonstrate its general fitness for service.

3. All defects shall be corrected, and adjustments made at the expense of the pumping system manufacturer.

4. Test shall be repeated until satisfactory results are obtained.

D. Start up assistance shall be limited to one day.

E. After the station startup has been completed, but before the technician leaves the job site, a training session shall be given to the owner and/or the owner's representative to familiarize them with the pumping system operation, maintenance and adjustments.

3.4 WARRANTY

A. The manufacturer shall warrant that the water pumping system shall be free of defects in workmanship for a period of one year from date of authorized start–up but not to exceed eighteen months from date of manufacturer's invoice.

B. Provided that all installation and operation responsibilities have been properly performed, manufacturer shall provide a replacement part or component during the warranty life. Any repairs to be accomplished at manufacturer's expense must be pre–authorized. The start–up certificate must be on file with manufacturer to activate warranty. Upon request, manufacturer shall provide advice for trouble shooting of a defect during the warranty period.

C. Manufacturer shall use only first quality material. As with any mechanical or electrical device, some preventive maintenance efforts are required to assure an adequate service life. A periodic preventive maintenance program recommendation shall be included in the owner's manual. Manufacturer shall support a large national network of technical service technicians. Manufacturer's field service technicians shall be contacted for service. Because of varied conditions beyond the control of manufacturer, this warranty may not be valid or may not cover damage as follows:

1. Default of any agreement with manufacturer.

2. Misuse, abuse, or failure to conduct routine maintenance.

3. Handling any liquid other than clean water.

4. Exposure to electrolysis, erosion, or abrasion.

5. Presence of destructive gaseous or chemical solutions.

6. Over voltage or unprotected low voltage.

7. Unprotected electrical phase loss or phase reversal.

END OF SECTION 44 42 56

INDEX TO

SECTION 44 42 73

PRESTRESSED CONCRETE EQUALIZATION STORAGE TANK

SECTION 44 42 73

PRESTRESSED CONCRETE EQ STORAGE TANK

PART 1 – GENERAL

1.1 WORK INCLUDED

A. Pre–stressed Composite Tank.

B. Equalization Pump

C. Course Bubble Diffuser

E. Piping.

F. Instrumentation

G. All necessary appurtenances related to convey sludge from this tank to the existing system as shown on the plans.

H. Site work.

1.2 RELATED WORK

A. Section 31 00 00 – Earthwork

B. Section 03 30 00 – Concrete

C. Section 05 50 00 – Miscellaneous metals

D. Section 09 900 00 – Painting

E. Section 26 05 00 – Electrical

1.3 REFERENCES

A. AWWA Specifications C100, C400, C600, C650, C800, C900 and D100 series (latest revision) shall be used as a guide.

1.4 OPTIONS

A. Where manufacturers of material or equipment are named in the specifications, the Contractor may use equipment or materials of other manufacturers provided they are reviewed and accepted by the Engineer as meeting the specifications.

1.5 QUALITY ASSURANCE

A. Materials – The Contractor will furnish the Engineer and the Owner a description of <u>all</u> material before ordering. The Engineer will review the Contractor's submittals and provide in writing an acceptance or rejection of material.

B. Manufacturer – Material and equipment shall be the standard products of a manufacturer who has manufactured them for a minimum of 2 years and who provides published data on the quality and performance of the products.

C. Tank Manufacturer – The tank shall be manufactured and erected by a tank builder who has designed and built storage tanks for a period of at least five (5) years and who publishes data on the tank he proposes to erect.

D. Subcontractor – A subcontractor for any part of the work must have experience on similar work and if required furnish the Engineer with a list of projects and the names of Owners or Engineers who are familiar with his capability.

E. Tank – The tank shall be a circular prestressed composite tank. Preference will be given to good appearing economical design. The manufacturing and erection of the storage tank shall be in strict accordance with the latest standard specifications for wire–wound circular pre–stressed concrete tanks, adopted by the American Water Works Association except where modified hereinafter. The tank is in a 160 MPH Hurricane Zone. It shall be designed in accordance with AWWA D–110 or latest revisions.

The tank will be designed for Seismic Zone #1. The capacity will be 500,000 gallons at the normal water level.

Devices, equipment, structures, and systems not designed by the Engineer that the Contractor wishes to furnish shall be designed by either a registered professional engineer or by someone the Engineer accepts as qualified. If required, complete design calculations and assumptions shall be furnished to the Engineer or Owner before acceptance.

F. Testing Agencies – Soil Testing shall be done by a testing laboratory which operates in accordance with ASTM E–329–77 (reapproved 1983 or latest revision) by the Engineer prior to engagement. Mill certificates of tests on materials made by the manufacturers will be accepted provided the manufacturer maintains an adequate testing laboratory, makes regularly scheduled tests that are spot checked by an outside laboratory, and furnishes satisfactory certificates with the name of the one making the test. Agencies to be used shall be submitted to the Engineer for review prior to engagement.

Hydrostatic tests on pipe shall be made by the Contractor with equipment qualified by the Engineer. The Engineer or his representative reserves the right to accept or reject testing equipment.

G. Lead Free material – All pipe material, solder and flux shall be lead free (less than .2 percent lead is solder and flux and less than 0.8 percent lead in pipes and fittings).

1.6 REQUIREMENTS OF REGULATORY AGENCIES

A. None required.

All portions of the tank, shall be of water–tight construction.

1.7 PRODUCT DELIVERY, STORAGE & HANDLING

A. Material shall be unloaded in a manner that will avoid damage and shall be stored where it will be protected and will not be hazardous to traffic. The Contractor shall repair any damage caused by the storage. Material shall be examined before installation and neither damaged nor deteriorated material shall be used in the work.

1.8 SEQUENCING, SCHEDULING

A. The Contractor shall submit a schedule showing the start and time required for each element of the work and shall order the material and equipment for delivery to match this schedule.

1.9 ALTERNATIVES

A. The intention of these specifications is to produce the best system for the Owner. If the Contractor suggests that alternate material, equipment or procedures will improve the results at no additional cost, the Engineer and the Owner will examine the suggestion and if it is accepted, it may be used. The basis upon which acceptance of an alternate will be given is its value to the Owner, and not for the convenience of the Contractor.

1.10 GUARANTEE

A. The tank construction company shall guarantee workmanship and materials on the complete structural portion of the tank for a five–year period from data of acceptance of the work. In case leakage or other defects appear within the five–year period, the tank construction company shall promptly repair the tank at its own expense upon written notice by the owner that such defects have been found. Leakage is defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from the inside of the tank.

To satisfy the five–year guarantee, tank Construction Company shall furnish a one–year performance and payment bond and a written company warranty for an additional four–year period.

On other related construction, the Contractor shall guarantee the quality of the materials, equipment, and workmanship for a period of 12 months after acceptance. Defects discovered during that period shall be repaired by the Contractor at no cost to the Owner. The Performance Bond shall reflect this guarantee.

1.11 EXISTING UTILITIES

A. All known utility facilities are shown schematically on plans and are not necessarily accurate in location as to plan or elevation. Utilities such as service lines or unknown facilities not shown on plans will not relieve the Contractor of his responsibility under this requirement. "Existing Utilities Facilities" means any utility that exists on the project in its original, relocated or newly installed position. The Contractor will be held responsible for the cost of repairs to damaged underground facilities; even when such facilities are not shown on the plans. The Contractor shall contact all utility companies prior to beginning work and request an accurate field location of their respective utility lines.

1.12 CONNECT NEW MAIN TO EXISTING SYSTEM

A. The Contractor shall furnish the necessary pipe and perform all excavation, dewatering, shoring, backfilling, etc., necessary to make the connection of a new main to the existing water system. The Contractor shall contact the Superintendent of the treatment plant a minimum of 48 hours in advance of construction. The Contractor shall be responsible for coordinating his construction with the utility operator.

1.13 DAMAGE TO EXISTING Utility SYSTEM

A. Damage to any part of the existing system by the Contractor or subcontractors that is repaired by the Utility owner's forces shall be charged to the Contractor on the basis of time and material, plus 30% for overhead and administration.

1.14 MEASUREMENT AND PAYMENT

A. Payment for the work covered by this Section shall be made under the lump sum item "Equalization Storage Tank". Payment shall include the site work, the cost of furnishing and erecting the tank, soil testing, foundations; painting; tank piping; and piping from the tank base elbow to outside the tank as shown on the construction drawings. Partial payments will be paid upon the submission of properly certified invoices.

PART 2 – PRESTRESSED CONCRETE FLOW EQUALIZATION TANK

2.1 SECTION INCLUDES

A. This section specifies the design and construction of an AWWA D110 Type II, wire–wound pre–stressed concrete storage tank with galvanized steel diaphragm complete including all reinforcing, concrete work, accessories, disinfection, and testing directly related to the tank.

B. The tank contractor is responsible for furnishing all labor, materials, tools, and equipment necessary to design and construct the pre–stressed concrete storage tank as indicated on the drawings and as described in this specification.

2.2 RELATED SECTIONS

A. Appendix A – Geotechnical Report

2.3 REFERENCES

A. ACI 117–10 – Specification for Tolerances for Concrete Construction and Materials

B. ACI 301/301M–10 – Specifications for Structural Concrete for Buildings

C. ACI 305R–10 – Guide to Hot Weather Concreting

D. ACI 306R–10 – Guide to Cold Weather Concreting

E. ACI 347R–04 – Guide to Formwork for Concrete

F. ACI 350/350R–06 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

G. ACI 350.3–06 – Seismic Design of Liquid–Containing Concrete Structures and Commentary

H. ACI 372R–03 – Design and Construction of Circular Wire– and Strand–Wrapped Prestressed Concrete Structures

I. ACI 506R–05 – Guide to Shotcrete

J. ACI 506.2–95 – Specification for Materials, Proportioning, and Application of Shotcrete

K. ACI SP4 – Formwork for Concrete

L. ANSI/AWWA D110–04 – Wire– and Strand–Wound, Circular, Prestressed Concrete Water Tanks

M. ASCE Standard 7–10 – Minimum Design Loads for Buildings and Other Structures

N. ASTM A416/A416M–12a – Standard Specification for Steel Strand, Uncoated Seven–Wire for Prestressed Concrete

O. ASTM A615/A615M–12 – Standard Specification for Deformed and Plain Carbon–Steel Bars for Concrete Reinforcement

P. ASTM A653/653M–11 – Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by Hot Dip Process

Q. ASTM A821/A821M–10 – Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks

R. ASTM A882/A882M–04(2010) – Standard Specification for Filled Epoxy–Coated Seven–Wire Prestressing Strand

S. ASTM A884/A884M–12 – Standard Specification for Epoxy Coated Steel Wire and Welded Wire Reinforcement

T. ASTM A1064/A1064M–12 – Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

U. ASTM C31/C31M–12 – Standard Practice for Making and Curing Concrete Test Specimens in the Field

V. ASTM C33/C33M–13 – Standard Specification for Concrete Aggregates

W. ASTM C39/C39M–12a – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

X. ASTM C143/C143M–12 – Standard Test Method for Slump of Hydraulic–Cement

Y. ASTM C172/C172M–10 – Standard Practice for Sampling Freshly Mixed Concrete

Z. ASTM C231/C231M–10 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method

AA. ASTM C881/C881M–10 – Standard Specification for Epoxy–Resin–Base Bonding Systems for Concrete

BB. ASTM D1056–07 – Standard Specification for Flexible Cellular Materials–Sponge or Expanded Rubber

CC. ASTM F593–13 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

DD. "Earthquake Induced Sloshing in Tanks with Insufficient Freeboard" by P.K. Malhotra, Structural Engineering International, IASBSE, 3/2006 pp 222–225

2.4 SUBMITTALS

A. Prequalification Data: Provide prequalification data prior to the bid in accordance with Section 1.5 B. of this specification.

B. Shop Drawings: Provide shop drawings with a minimum size of 18" x 24" with a complete plan, elevation, and sectional views showing critical dimensions as follows:

1. Size, location, and number of all reinforcing bars.
2. Thickness of all parts of the tank structure including floor, core wall, and covercoat.
3. Prestressing schedule including number and placement of prestressing wires on the tank wall and total applied force per foot of wall height.
4. Location and details of all accessories required.

C. Concrete Data: Submit concrete design mixes including ingredient proportions, minimum cementitious content, and water/cementitious ratio in accordance with Section 2.2 and 2.3 of this specification.

D. Design Data: Submit structural calculations for the tank, signed and sealed by a professional engineer in accordance with Section 1.5 A.3 of this specification.

E. Coating Data: Submit color charts for review by the engineer and owner. Once a color is chosen, submit actual drawdown samples for final approval prior to application of coating.

F. Test Reports: Submit concrete strength reports for 7–day and 28–day breaks taken in accordance with the requirements of Section 3.3 A.1.

G. Warranty Document: Submit warranty document in Owner's name in accordance with Section 1.6 A. of this specification.

H. Cleaning Plan: Submit a cleaning plan which complies with Section 3.4 of this specification.

I. 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.

2.5 QUALITY ASSURANCE

A. Qualifications and Experience:

1. Tank Construction Company: The owner desires a firm with five years of experience in the design and construction of ANSI/AWWA D110 Type II wire–wound, circular pre–stressed concrete tanks. The firm constructing the tank shall have designed and built with its own resources, a minimum of three (3) dome–covered pre–stressed concrete tanks of similar size and complexity in the last three years, which meet these specifications and are now providing satisfactory service. A firm meeting this requirement will ensure that the owner's tank is constructed by a company with the organization, technical skill, quality control, reliability, and financial stability to guarantee the tank.
2. Construction: The entire tank, including all portions of the floor, wall, and roof shall be built by the tank construction company, using its own trained personnel and equipment.
3. Design: All design work for the tank shall be performed by a professional engineer with no less than five years of experience in the design and construction of ANSI/AWWA D110 Type II wire–wound, circular prestressed concrete tanks. The professional engineer shall be a full–time staff member of the tank construction company and shall be licensed to work in the state where the project is located.
4. The diaphragm design and epoxy injection procedure shall have been used in the three tanks required in Section 1.5 A.1 of this specification.
5. The following are preapproved as acceptable tank construction companies:

   i. The Crom Corporation, Gainesville, Florida.
   ii. Precon Corporation, Newberry, Florida.

2.6 WARRANTY

A. Provide a warranty document for workmanship and materials on the complete structural portion of the tank for a five–year period from the date of acceptance of the work. In case leakage or other defects appear within the five–year period, the tank construction company shall promptly repair the tank at its own expense upon written notice by the Owner that such defects have been found. Leakage is defined as a stream flow of liquid appearing on the exterior of the tank, the source of which is from the inside of the tank. The tank construction company shall not be responsible for, nor liable for, any subsurface condition. This warranty shall not apply to any accessory, equipment or product that is not a structural part of the tank and is manufactured by a company other than the tank construction company.

2.7 DESIGN CRITERIA

A. The design shall be in conformance with applicable portions of American Concrete Institute (ACI) 372R Design and Construction of Circular Wire– and Strand–Wrapped Pre–stressed Concrete Structures, ANSI/AWWA D110 Wire– and Strand–Wound, Circular, Pre–stressed 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. Capacity: 1,500,000 Gallons
2. Dimensions: 100 ft. Inside Diameter
   25 ft. Water Depth
3. Fluid Loads: Shall be the weight of all liquid when the reservoir is filled to capacity. The unit weight of the liquid material shall be 62.4 lbs/ft^3.
4. Dead Loads: Consideration shall be given to all permanent imposed loads including concrete and steel.
5. Seismic Loads: Seismic forces and moments resulting from water sloshing and seismic accelerations of the tank wall and water loads shall be calculated in accordance with ACI 350.3 or ANSI/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.

C. Floor: The design of the floor for the pre–stressed concrete tank shall conform to the following:

1. Concrete membrane floors shall be a minimum of 4 in. thick and have a minimum thickness of 8 in. of concrete over all pipe encasements and around sumps.
2. A minimum percentage of 0.60% reinforcing steel shall be used in the membrane floor. The minimum percentage shall apply to all thickened sections and shall extend a minimum of 2 ft into the adjacent membrane floor.

D. Core wall:

1. The wire–wound, pre–stressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, galvanized steel shell diaphragm.

2. The design of the core wall shall take into account appropriate edge restraint. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following minimum reinforcing steel shall be incorporated into the design:

   a. The top 2 ft. of core wall shall have not less than 1% circumferential reinforcing.
   b. The bottom 3 ft. of core wall shall have not less than 1% circumferential reinforcing.
   c. Inside Face:

      (1) The inside face of the core wall shall utilize the diaphragm as effective reinforcing.
      (2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.

   d. Outside Face:

      (1) Vertical reinforcing steel in the outside face of the core wall shall be: minimum of #4 bars at 12 in. center to center.
      (2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.

3. The minimum core wall thickness shall be 3½ in.
4. Reinforcing steel used in the core wall shall be designed using a maximum allowable design tensile stress, f_s, of 18,000 psi.
5. Allowable compressive stress in the core wall due to initial prestressing force, f_{gi}, shall be:

   a. 1250 psi + 75t psi/in. with 0.5 f'_{gi} maximum or less (where f'_{gi} is defined as compressive strength at time initial prestressing force is applied and *t* is the thickness of the core wall in inches).
   b. Maximum of 2250 psi.

6. Allowable compressive stress in the core wall due to final prestressing force, f_g, shall be:

   a. 1250 psi + 75t psi/in. with 0.45 f'_g maximum (where f'_g is defined as compressive strength required for final prestressing force and *t* is the thickness of the core wall in inches).
   b. Maximum of 2025 psi.

E. Prestressing:

1. Circumferential prestressing of the tank shall be achieved by the application of cold–drawn, high–carbon steel wire placed under high tension.
2. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.
3. The prestressing design shall conform to the following minimum requirements:

a. Working stress for the tank wall, fs, shall be a maximum of 115,000 psi.
b. The allowable design tensile stress in the prestressing wire before losses, fsi shall be 145,600 psi or no greater than 0.63 fu, where fu is defined as the ultimate strength of the wire.
c. Areas to be pre–stressed will contain no fewer than 10 wires per foot of wall for 8 gauge and 8 wires per foot of wall for 6 gauge.
d. A maximum of 24 wires per layer per foot for 8 gauge and 20 wires per layer per foot for 6 gauge will be allowed.

F. Wall Openings:

1. When it is necessary for a pipe to pass through the tank wall, the invert of such pipe or sleeve shall be no less than 18 in. above the floor slab. The prestressing wires required at the pipe elevation shall be distributed into circumferential bands immediately above and below the opening to maintain the required prestressing force while leaving an unbanded strip around the entire tank.
2. Unbanded strips shall have a vertical dimension of no more than 36 in. unless an axi–symmetric shell analysis is performed to account for compressive forces plus shear and moments caused by displacement of the pre–stressing wires into adjacent bands.

PART 3 – PRODUCTS

3.1 PERFORMANCE

A. Performance of the materials used in the tank construction shall conform to the minimum requirements of this specification.

B. Substitutions to the materials in this specification may only be made if submitted in writing and approved by the engineer.

3.2 CONCRETE

A. Concrete shall conform to ACI 301/301M.

B. All concrete shall utilize Type I/II Portland cement.

C. A maximum of 25% of cementitious material may be fly ash.

D. Admixtures other than air–entraining and water reducing admixtures will not be permitted unless approved by the engineer.

E. Coarse and fine aggregate shall meet the requirements of ASTM C33/C33M.

F. Concrete mixes used in the construction of the tank shall conform to the following:

G.

Mix	Compressive Strength (psi)	Minimum Cement Content (lbs)	Maximum Aggregate Size (in)	Maximum W/C Ratio	Air Content (%)	Slump (in)
Floor	4000	560	¾	0.45		4"+/– 1"

3.3 SHOTCRETE

A. Shotcrete shall conform to the requirements of ACI 506.2 except as modified herein.

B. All shotcrete mixes shall utilize Type I/II cement.

C. A maximum of 25% of cementitious material may be fly ash.

D. All shotcrete in contact with diaphragm or prestressing wire shall be proportioned to consist of not more than three parts sands to one–part Portland cement by weight. All other shotcrete shall be proportioned to consist of not more than four parts sands to one part Portland cement by weight.

E. Admixtures will not contain more than trace amounts of chlorides, fluorides, sulfides or nitrates.

F. Fine aggregate shall meet the requirements of ASTM C33/C33M.

G. Shotcrete mixes used in the tank construction shall conform to the following:

Mix	Compressive Strength (psi)	Maximum W/C Ratio	Air Content (%)	Slump (in)	Fiber Reinforcement (lbs/cyd)
Core Wall	4000	0.42		4"+/–1"	–
Cover coat	4000	0.42		4"+/–1"	

3.4 PRESTRESSED REINFORCEMENT

A. The prestressing wire shall conform to the requirements of ASTM A821/A821M, Type B.

B. The prestressing wire size shall be 0.162 in. (8 gauge), 0.192 in. (6 gauge) or larger, but no larger than 0.250 in.

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.

D. Splices for horizontal prestressed reinforcement shall be ferrous material compatible with the prestressing reinforcement and shall develop the full strength of the wire.

3.5 NON–PRESTRESSED REINFORCEMENT

A. Non–prestressed mild reinforcing steel shall be new billet steel meeting the requirements of ASTM A615/A615M with a minimum yield strength, f_y, of 60,000 psi.

B. Welded wire reinforcing shall be plain wire conforming to the requirements of ASTM A1064/A1064M with a minimum yield strength, f_y, of 65,000 psi.

3.6 GALVANIZED STEEL DIAPHRAGM

A. The galvanized steel diaphragm used in the construction of the core wall shall be 26 gauge with a minimum thickness of 0.017 in. conforming to the requirements of ASTM A653/A653M. Weight of zinc coating shall be not less than G90 of Table 1 of ASTM A653/A653M.

B. The diaphragm shall be formed with re–entrant angles and erected so that a mechanical key is created between the shotcrete and diaphragm.

C. The diaphragm shall be continuous to within 3 inches of the top and bottom of the 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.

3.7 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.

3.8 EPOXY

A. Epoxy Sealants:

1. Epoxy shall conform to the requirements of ASTM C881/C881M.

2. Epoxy used for sealing the diaphragm shall be, Type III, Grade 1, and shall be 100% solids, moisture insensitive, low modulus epoxy.
3. Epoxy used for placing the waterstop shall be Type II, Grade 2, and shall be 100% solids, moisture insensitive, low exotherm epoxy.
4. When pumped, maximum viscosity of the epoxy shall be 10 poises at 77°F.
5. 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 C881/C881M.
2. Epoxy resins shall be a two–component, 100% solids, and moisture–insensitive epoxy and shall be Type II, Grade 2.

3.9 SEISMIC RESTRAINT CABLES

A. When required by design, seismic restraint cables shall be seven–wire strand conforming to ASTM A416/A416M.

B. The strand shall be protected with a fusion–bonded, grit–impregnated epoxy coating conforming to ASTM A882/A882M.

C. The minimum yield strength of the seven–wire strand shall be 270,000 psi.

3.10 TANK ACCESSORIES

A. Minimum of one, 1' 5" x 4' 4" rectangular Type 316 stainless steel wall manhole for access to the interior of the tank. The cover shall also be of Type 316 stainless steel. The wall manhole shall be designed to resist hydraulic loading without excessive deflection.

B. Exterior ladder-- No need for exterior ladder

C. Interior ladder shall be fabricated from fiberglass shall conform to all applicable OSHA standards. The ladder shall have a safety climbing device manufactured from Type 316 stainless steel as required to meet applicable OSHA standards.

D. Through–wall pipe sleeves shall be Type 316 stainless steel sleeves with neoprene modular seal units.

E. Accessory hardware, unless otherwise noted, shall be Type 316 stainless steel conforming to ASTM F593.

3.11 COATINGS

A. Exterior coating system shall consist of one of the following:

1. Two coats Tnemec Series 156 Enviro–Crete Modified Waterborne Acrylate.
2. Two coats Thoroseal Waterproof Cement–Based Coating.

PART 4 EXECUTION

4.1 EXAMINATION

A. All subgrade elevations shall be verified prior to starting tank construction.

4.2 INSTALLATION

A. Floor:

1. The subgrade shall be prepared by fine grading to ensure proper placement of reinforcing steel with proper bottom cover.
2. A 6–mil polyethylene vapor–barrier shall be placed after subgrade preparation has been completed.
3. Form and screed boards shall be of proper thickness and sufficiently braced to ensure that the floor is constructed within proper thickness tolerances.
4. Plate bolsters shall be used to support reinforcing steel supported directly on the subgrade to ensure positive control of placement of reinforcing steel.
5. The floor shall be vibratory screeded to effect consolidation of concrete and proper encasement of floor reinforcing steel.
6. The floor shall be water cured for a minimum of 7 days after casting.
7. The floor shall receive a light broom finish.

B. Core Wall:

1. The wall shall be constructed utilizing diaphragm and shotcrete with each conforming to the following:

a. Diaphragm Erection:

(1) The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the diaphragm for erection except in the top 3 inches. Holes shall not be made in the diaphragm 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.

b. Shotcrete

(1) 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.

(2) Each shotcrete layer shall be broomed prior to final set to effect satisfactory bonding of the following layer.

(3) No shotcrete shall be applied to reinforcing steel or diaphragm that is encrusted with overspray.

(4) No less than ⅛ in. thick shotcrete shall separate reinforcing steel and prestressing wire.
(5) The diaphragm shall be encased and protected with no less than 1 in. of shotcrete in all locations.
(6) The interior shotcrete shall receive a light broom finish.

c. Curing:

(1) Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is completed.

C. Epoxy Injection:

1. Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure.
2. Epoxy injection shall proceed only after the diaphragm has been fully encased, inside and outside, with shotcrete.

D. Prestressing:

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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.
7. When multiple layers of wire are required, shotcrete cover between layers shall be no less than ⅛ in. thick.

E. Cover coat:

1. After all circumferential prestressing wires have been placed, a shotcrete cover having a thickness of no less than 1 in. shall be placed over the prestressing wires.
2. Horizontal sections of the wall shall form true circles without flat areas, excessive bumps or hollows.
3. The cover coat shall receive a sliced trowel finish.

F. Wall Openings:

1. All wall pipes, sleeves and manholes passing through the wall shall be sealed to the diaphragm by epoxy injection.

H. Coatings:

1. All coatings shall be applied a minimum of 28 days after final application of concrete or shotcrete.
2. All application procedures for coatings shall be in accordance with manufacturer's recommendations.

4.3 FIELD QUALITY CONTROL

A. Inspection and Testing:

1. Concrete and Shotcrete Testing:

a. Compression Tests:

(1) 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 50 yards of concrete/shotcrete placed. Each set of test specimens shall be a minimum of 5 cylinders.

(2) Compression test specimens for concrete/shotcrete shall conform to ASTM C172/C172M for sampling and ASTM C31/C31M 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.

(3) Compression test shall be performed in accordance with ASTM C39/C39M. 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:

(1) Air content tests shall conform to ASTM C231/C231M (Pressure Method for Air Content).

(2) Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.

c. Slump Tests:

(1) Slump tests shall be made in accordance with ASTM C143/C143M.
(2) Slump tests shall be made whenever compression test specimens are made.

2. Hydrostatic Testing:

a. The tank shall be tested for watertightness upon completion.
b. The testing for watertightness shall be completed as follows:

(1) Fill the tank with water to the maximum water level and let it stand for a minimum of 24 hours.
(2) Inspect the exterior of the tank wall and footing for damp spots. Damp spots shall be defined as spots where moisture can be picked up on a dry hand, the source of which is from inside the tank.
(3) Leakage through the wall or wall–base joint shall be repaired, and the tank shall be retested using the above procedure.

4.4 CLEANING

A. The interior of the tank shall be cleaned to remove debris, construction items, and equipment prior to testing.

END OF SECTION

INDEX TO

SECTION 44 43 34 – INFLUENT DRUM SCREEN

SECTION 44 43 34

INFLUENT DRUM SCREEN

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. There shall be furnished three (3) Model RDS60120DVT Rotoshear PF EZ–Care units, manufactured by Parkson Corporation, Vernon Hills, IL or equivalent pre–approved equal. Each rotating drum screen shall consist of a screen cylinder, base –frame, tub headbox and distribution pan, splash guards, hood and support structure, trunnion wheel assemblies, spray wash system, cylinder stabilizer and positive drive assembly.

The unit shall also be provided with the following optional features: drain pan with support legs, discharge end enclosure with chute and controls.

B. The equipment shall be of the latest design and shall be fabricated of the specified materials and in a fashion, that will fully perform the functions described in these specifications.

1. The screen shall be designed to minimize the time required for routine preventative maintenance. The labor hours presented in the table below define the maintenance requirements. Rotating drum screens that do not meet the following criteria are not acceptable.

Maintenance Item	Maintenance Requirement
Drive System Lubrication	0 hours / year (self-lubricated)
Stabilizer Pad Lubrication	0 hours / year (self-lubricated)

2. The screen shall be designed to facilitate quick and easy replacement of typical wear parts. The labor hours presented in the table below define the maintenance requirements. Rotating drum screens that do not meet the following criteria are not acceptable.

Replacement Item	Replacement Requirement
Chain and Sprocket	2 hours
Trunnion Wheels, Qty 4/unit, For one (1) wheel	0.5 hours
Stabilizer Pad	0.5 hours

1.2 RELATED WORK

A. The following sections apply to the work in this section

1. Wash Press

1.3 REFERENCES STANDARDS

A. The design, manufacture, and installation of this equipment will meet or exceed the applicable provisions and recommendations of the following current editions of codes and standard authorities, except where otherwise shown or noted:

1. AGMA, American Gear Manufacturers Association
2. ASME, American Society of Mechanical Engineers
3. ASTM, American Society of Testing and Materials
4. ANSI, American National Standards Institute
5. NEC, National Electric Code
6. ABMA, American Bearing Manufacturers Association

1.4 EXPERIENCE

A. The screen manufacturer will have 10 years design and manufacturing experience with internally–fed perforated drum screens, with no less than fifteen (15) similar units installed within the US as screening devices in similar applications.

1.5 PRE–BID SUBMITTALS

A. The screen is the basis of design. Alternative suppliers shall be considered and shall be so named by addendum prior to the bid. To be considered as an equal the alternative supplier shall submit to the engineer the following information at least 21 days prior to the advertised bid date. Complete submittal drawings, quality control and product information will be submitted in electronic and hard copy format, 5 copies required. As a minimum, the following information will be submitted:

1. A Letter of Compliance, which confirms any variances with the Contract Plans and Specifications and provides further explanations where necessary to adequately define the scope of supply.

2. Dimensional plan and section drawings of the equipment mounted in the structure, showing all utility connections and requirements, and anchor bolt locations. Where applicable, drawings will show connection to associated equipment provided by others.

3. Approximate weight of each component or piece of equipment.

4. Manufacturers' catalog information, descriptive literature, specifications, and identifications of material of construction.

5. Power and control wiring diagrams, including terminal layout with numbers, panel construction and panel layout drawings, and control schematics diagrams. Control diagrams will also include a description of operation.

6. Manufacturers' performance data for all drives.

7. Installation, Operation and Maintenance manuals in electronic format for owner review.

1.6 SPARE PARTS

A. No spare parts will be required for the manufacturer as the owner currently maintains required parts in inventory design.

B. Alternative designs shall provide a complete set of drive and driven sprockets or gears as well as drive chains if utilized. One replacement gear reducer with motor. A full set of trunnions with bearings and supports. A full set of spray wash nozzles. Any wear component of the design that will require replacement within the first 5 years of operation.

1.7 BASIS OF DESIGN

A. Equipment Layout: The contract documents and specifications are based on the Parkson manufacturer. Any changes in layout, access platforms, piping or structural requirements for an alternative manufacturer's design will be the responsibility of the installing contractor, including the cost of the engineer to verify layout, sizing, and structural requirements.

B. Standard Designs: Where a manufacturer's standard equipment and/or model number is listed, the equipment shall be provided as modified to conform to the performance, function, features, and materials of construction as specified herein.

1.8 PERFORMANCE AND DESIGN REQUIREMENTS

A. The unit shall be capable of the following performance:

1. The liquid/solids mixture to be screened will be introduced to the internal surface of the screen cylinder with the solids being conveyed to the discharge end of the cylinder by diverters arranged in a helical pattern. Solids discharged out of the cylinder are directed into a collection device. The screened fluid passes through the perforated cylinder and is directed on to the next process.

2. The unit will be installed outdoors, in an unclassified area.

3. The unit's controls will be installed outdoors, in an unclassified area.

4. The unit will be suitable for installation and operation in the designated environment.

5. The unit will be capable of treating a peak flow of **7.5 MGD** per screen with a maximum suspended solids concentration of 250 mg/l without overflow or bypassing.

6. Utilities

a.	External spray wash (@ 80 psi):	23 gpm
b.	Internal spray wash (@ 80 psi):	19 gpm
c.	Power Supply	460 /3/ 60

1.9 WARRANTY

The equipment warranty shall be for a period of one (1) year from being placed into operation, not to exceed 18 months from the date of delivery. The equipment shall be free from defective material and workmanship, under normal use and service and when installed, operated and maintained in accordance with installation instructions, and maintenance/operating procedures.

PART 2 – PRODUCTS

2.1 QUALITY ASSURANCE

1. The equipment shall include all necessary safety devices, such as machinery guards, emergency stops, warning labels, and similar items.

2. Threaded fitting shall have a standard tapered pipe threads complying with ANSI/ASME B1.20.1.

3. Bearings shall conform to the standards of ABMA.

4. Gear reducer selections shall comply with AGMA standards and gear reducer's recommendations.

5. Nameplates shall be engraved stainless steel and stamped and fastened to the equipment with stainless steel rivets.

6. The equipment shall be manufactured in the United States by a manufacturer that is ISO 9001 certified.

7. The equipment shall be factory assembled and tested for a minimum of thirty (30) minutes at the U.S. factory prior to delivery. The Engineer and/or Owner may witness the factory test, at their own option and expense.

8. The equipment shall be delivered to the site as fully assembled as possible. Some components may be removed from the unit after shop testing to prevent damage during shipment' these components must be re–assembled on the unit by the Contractor.

2.2 MATERIALS OF CONSTRUCTION AND FABRICATION

A. Screen Cylinder: The screening element shall be a cylinder constructed of type 316 stainless steel perforated plate, reinforced by a substructure and full continuous internal flight. Each end of the screen element shall be fitted with a type 316 stainless steel end ring welded to the screen substructure throughout the circumference. One end ring shall be considered the drive end and provide the necessary attachment of the drive sprocket. The other end ring shall be considered the discharge end and be designed with an extended bell mouth to provide the effective discharge of dewatered solids away from the base of the unit. The screening cylinder shall measure at a minimum 60" in diameter x 120" in length.

The screening element shall be made of 24 GA (.023 inch) type 316 stainless steel perforated sheet. The sheet shall have 2 mm [0.079 inch] diameter perforations. Each longitudinal end of the perforated sheet shall be bent outward to form a mounting lip. These bends shall not be perforated but shall be provided with a mounting hole pattern to allow the sheets to be fastened to the substructure. Wire mesh screening panels or elements shall not be acceptable.

The substructure shall include four equally spaced longitudinal reinforcing bars welded to the screen end rings. A full continuous flight shall be welded to the interior of the reinforcing bars. The flight shall be made of ¾" diameter type 304 stainless steel pipe, with a pitch of 24.00 inches.

Stainless steel diverters shall be welded to the interior of the end rings to facilitate conveying of screened solids. The diverter height shall be a minimum of 1/2 inch.

B. Base Frame: The base frame of the unit shall be fabricated of type 316 stainless steel. The base frame assembly shall be accurately fabricated to provide a mounting surface for the screen assembly. The frame shall be designed to withstand the loads imposed by the headbox structure and rotating screen cylinder. The base shall also be designed to allow for 4-point support at each corner without undue deflection throughout its length.

C. Tub Headbox and Distribution Pan: The headbox and distribution pan shall be designed to receive the incoming flow and distribute the flow to the screen cylinder.

The incoming flow shall be introduced into the headbox by a 24.00-inch diameter inlet pipe. Inlet piping must be sized to ensure that the flow entering the inlet pipe does not exceed 5 ft/sec. The flow shall be baffled in the headbox to reduce forward velocity and provide momentary flow equalization.

The flow shall be directed from the headbox into the distribution pan, which is cantilevered into the center of the screen cylinder. The pan shall be provided with an open tapered header that controls and equally distributes flow. The final distribution of the flow onto the screen cylinder shall be made by a lexan curved weir located on each side of the distribution pan. Each weir shall have a maximum hydraulic loading not to exceed 36.52 GPM per lineal inch.

The headbox and distribution pan shall be fabricated with minimum 10-gauge type 316 stainless steel components. The headbox shall have a removable stainless-steel cover. The headbox and distribution pan shall be provided with cleanout and drain ports for maintenance purposes.

The influent pipe shall be provided with a type 316 stainless steel face ring and a 24.00-inch nominal diameter type 316 stainless steel loose back-up flange having a 125/150# class flange bolt pattern.

D. Splash Guards: External splash guards shall be designed to contain and direct flow through the base discharge opening. The splash guards shall be constructed of minimum 16-gauge type 316 stainless steel and be fitted on each side of the screening element.

The splash guards shall be fastened on the sides of the hood support structure. The guards shall be designed to be removed for maintenance purposes.

The splash guards shall allow maximum access for routine inspection and maintenance of trunnion wheels, spray bars and all other moving parts.

Access doors with viewing ports shall be provided on the splash guards near the trunnion wheels. Access door shall allow access to the trunnion wheels for routine servicing of the trunnion wheels. Viewing ports shall allow guarded viewing of the operating trunnion wheels for routine inspection.

No access door shall be provided for drive corner trunnion wheel. This trunnion wheel will be accessed through the drive system cover.

E. Hood and Support Structure: A hood shall be supplied to enclose the top of the screen cylinder for misting and odor retention. It shall be fabricated of minimum 14–gauge type 316 stainless steel welded to a support structure. The support structure shall be fabricated of type 316 stainless steel formed structural shapes.

F. Trunnion Wheel Assemblies: The unit shall be provided with four (4) trunnion wheels assemblies. Trunnion wheel assemblies shall be accurately mounted to the base frame to provide positive horizontal placement of the screen cylinder.

1. Trunnion Wheel: Each trunnion wheel shall be constructed of solid polyethylene with an outside diameter of 8 inches. The wheel shall be counter bored for mounting a flanged ball bearing on each side. Flange bearings shall be bolted to each other and to the center of the wheel. Flange bearings shall be sealed and lubricated with oil releasing permanent lubricant, requiring no additional lubrication throughout the life of the bearings.

   Trunnion wheels which require periodic lubrication are not acceptable.

2. Support Shaft: The support shaft shall be of type 316 stainless steel having a minimum diameter of 1–1/2 inches. The shaft shall be mounted in the wheel bearings and accurately positioned and secured by the trunnion wheel support bracket.

3. Trunnion Wheel Support Bracket: The bracket shall be designed to locate the trunnion support shaft and support the loads imposed by the cylinder. The bracket shall include a shaft cradle, which is designed to align and hold the position of the shaft, and to facilitate quick removal and installation of the trunnion wheel and shaft.

   Trunnion wheel brackets without quick release functionality are not acceptable.

4. Trunnion Wheel Replacement Tool: Each screen shall be provided with one removable (1) trunnion wheel replacement tool, which shall lift the screen cylinder when a trunnion wheel requires replacing.

Screens supplied without a trunnion wheel replacement tool are not acceptable.

G. SPRAY WASH SYSTEM

1. External Spray: An external water spray system shall be provided to clean the screen cylinder from the outside. The spray header shall be constructed of a 1–1/2inch Schedule 40 type 316 stainless steel pipe and shall be drilled and tapped to provide the means to mount spray nozzles. Tapped holes shall have a minimum of five (5) effective threads to ensure proper engagement of the nozzles into the header and prevent stripping or galling of the tapped hole threads. Header designs with tapped holes having less than five (5) effective threads are not acceptable. Header consists of 23 Nozzles.

   The nozzles shall be spaced to provide complete coverage of the screen, and spray at an angle of 90 degrees relative to the screen surface to ensure spray penetration through the cylinder openings. The nozzles shall be made of plastic and shall be a quarter–turn quick disconnect design to facilitate easy removal of the nozzle tip for cleaning. Designs without quarter–turn nozzles are excluded due to the risk of thread stripping and galling of the tapped holes or the nozzles.

   The external spray system requires a clean water supply of 23 gpm at 80 psin at the spray header. Clean water must be filtered to a minimum of 60 mesh / 250 micron (filter to be provided by contractor).

2. Internal Spray: An internal water spray system shall be provided to clean the screen cylinder from the inside. The spray header shall be constructed of a 1–1/ inch Schedule 40 type 316 stainless steel pipe and shall be drilled and tapped to provide the means to mount spray nozzles. Tapped holes shall have a minimum of five (5) effective threads to ensure proper engagement of the nozzles into the header and prevent stripping or galling of the tapped hole threads. Header designs with tapped holes having less than five (5) effective threads are not acceptable. Header consists of 19 Nozzles.

   The nozzles shall be spaced to provide complete coverage of the screen, and spray at an angle of approximately 15 degrees below horizontal. The nozzles shall be made of plastic and shall be a quarter–turn quick disconnect design to facilitate easy removal of the nozzle tip for cleaning. Designs without quarter–turn nozzles are excluded due to the risk of thread stripping and galling of the tapped holes or the nozzles.

   The internal spray system requires a clean water supply of 19 gpm at 80 psi at the spray header. Clean water must be filtered to a minimum of 60 mesh / 250 micron (filter to be provided by contractor).

   a. Internal Deflector: An internal deflector shall be provided to cover the internal spray bar assembly. The deflector shall be designed so as not to interfere with the spray pattern yet provide adequate protection from solids that may otherwise accumulate on the spray bar and nozzles. The deflector shall be constructed of minimum 16–gauge type 304 stainless steel.

H. Cylinder Stabilizer: A cylinder stabilizer assembly will be provided at the discharge end of the screen cylinder to maintain proper cylinder position along the longitudinal axis of the unit.

1. The cylinder stabilizer assembly shall include a plastimeric guide, which straddles the flange on the discharge head of the screen cylinder and limits cylinder movement to +/– 1/8 inch. The replaceable guide shall not require any lubrication.

2. The guide shall be mounted in an easily accessible type 316 stainless steel mounting bracket.

   Stabilizer mechanisms that have moving parts, require any type of periodic lubrication, or are mounted under the screen cylinder are not acceptable.

I. POSITIVE DRIVE ASSEMBLY

1. Drive: The unit shall be equipped with a gear reducer and motor to provide rotational motion to the screen cylinder. The screen unit shall be equipped with a 230/460 voltage, 3 Phase, 60 Hz, 2.0 HP motor. The motor shall have a 1.15 service factor and be suitable for use in a severe environment. The motor shall be close coupled to a foot mounted parallel helical gear reducer. The reducer output shaft shall be keyed to accept a drive sprocket and produce an output speed of 27 rpm.

   The drive shall be mounted on an adjustable base, which will allow the adjustment needed to maintain proper chain tension.

2. Chain & Sprocket: The screen shall have a chain and sprocket positive drive system that shall eliminate the periodic lubrication requirement.

   Screen drive assembly shall consist of a hybrid plastic chain, a hybrid drive sprocket, and a non–metallic driven sprocket. Hybrid assembly of the plastic chain shall minimize the friction coefficient between the sprocket teeth and the chain rollers and eliminate the need for grease or oil lubrication. A drive system that requires periodic lubrication (oil or grease) is not acceptable.

   The drive sprocket shall be manufactured in the following three (3) pieces for ease of installation and maintenance:

   - Stainless steel hub mounted on the drive output shaft.
   - Replaceable non–metallic sprocket plate.
   - Stainless steel keeper plate and fasteners.

   The design of the drive sprocket assembly shall allow the replacement of the drive sprocket plate without removing the hub from the drive output shaft. This design shall minimize downtime of the unit when replacing the drive components.

All positive drive system components shall be made of corrosion resistant materials due to the highly corrosive environment. Drive systems made completely of metallic components (carbon steel or stainless steel) that are subject to corrosion and frequent replacements are not acceptable.

J. Discharge End Enclosure: A discharge end enclosure, fabricated of minimum 12–gauge type 316 stainless steel, shall be provided to enclose the discharge end of the screen cylinder, control misting, and direct screenings into a screenings chute or receptacle. The enclosure will be provided with a plain end connection to properly fit up with a chute extension.

A screenings chute extension, fabricated of minimum 12–gauge type 316 stainless steel, shall be provided to direct screenings from the discharge end enclosure into the wash press inlet hopper below. The conveyance tube for screenings from the chute extension to the inlet of the wash press shall be provided by the contractor.

K. Drain Pan and Legs: A drain pan, fabricated of minimum 12–gauge type 316 stainless steel, shall be provided to collect liquid effluent and direct it into the discharge piping (provided by others). The drain pan shall be bolted to the underside of the unit base frame and shall be provided with a 30.00–inch OD bottom pipe connection. The depth of the drain pan shall be sufficient to prevent overflowing at the specified peak flow rate, in a free discharge condition.

The drain pan effluent pipe shall be provided with a type 316L stainless steel face ring and a 30.00–inch nominal diameter type 304 stainless steel loose back–up flange having a 125/150# class flange bolt pattern.

Four (4) support legs shall be provided to elevate the unit and allow proper fit of the drain pan. The support legs shall be constructed of the same material as the base frame.

Drain pan and legs shall be shipped loose for field assembly.

L. Anchor Bolts: Eight (8) Dia 3/4"–10 UNC type 316 stainless steel anchors shall be provided by the installing contractor to secure the screen to the structure. Length shall be decided by installing contractor.

M. Fasteners: All fasteners shall be type 18–8 stainless steel.

N. SURFACE FINISH

1. All stainless-steel sub–assemblies shall be acid passivated after welding for corrosion resistance and to provide a superior surface finish. This shall be done by full dipping of weldments; or by using an acid passivation paste in the weld and heat affected areas and spray–on acid solutions elsewhere. After passivation, the weldments shall be thoroughly rinsed with clean water and allowed to air dry. Sandblasting, sanding, bead blasting, or grit blasting of stainless-steel surfaces will not be allowed in lieu of acid passivation.

2. All carbon steel surfaces shall receive a minimum SSPC–SP6 commercial sandblast treatment. The sandblasted surface shall then receive a minimum of one coat of Carboline Industrial Grade Primer with a minimum of 1.5 mils dry film thickness. The finish shall be a minimum of two coats of Carboline 890 High–Build Epoxy, each coat having a minimum dry film thickness of 2 mils. The finished color shall be black.

3. Motor, gear reducer, bearings and chain shall be provided with the manufacturers' standard finish suitable for a severe environment.

4. Plastic parts shall remain unfinished.

O. ELECTRICAL DEVICES

In addition to the drive motor, the following electrical devices shall be furnished with the unit:

1. Interlock Switch: A NEMA 4X interlock switch shall be fitted on each side splash guard. Interlock switch shall be rated for use in a 120–volt circuit and provided with a 72–inch–long 18/2 lead.

   The unit shall be provided with a total of four (4) interlock switches.

   Each switch shall be wired to the control panel to cause the unit to completely stop rotating upon opening of the guard. Switches shall be powered through intrinsically safe relays in the control panel, which requires wiring in conduit separate from 120–volt wiring. Proper wiring from the switches to the control panel shall be the responsibility of the contractor.

2. Emergency Stop Local Push Button Station: A NEMA 4X polycarbonate emergency stop push button station shall be mounted to the headbox. E–stop will be rated for use in a 120–volt circuit and provided with a 1/2" conduit connection.

   E–Stop shall be wired to the control panel to cause all unit functions to cease upon pressing the E–Stop. Proper wiring from the E–Stop to the control panel shall be the responsibility of the contractor.

3. Spray Solenoid Valve: Slow closing valve shall be provided. While the unit is in operation, each water spray shall be actuated by a normally closed solenoid valve. Each solenoid valve shall have a brass body with 1–1/2" NPT pipe connections.

   Each solenoid valve requires 115–volt, 60 Hz, single phase power and shall be provided with an 18–inch–long 18/3 lead. Electrical housing shall be rated NEMA 4X and provided with a ½" NPT conduit connection. Each solenoid valve shall be field installed by the contractor in the respective wash water supply line. Proper wiring from the solenoid valve to the control panel shall be the responsibility of the contractor.

4. Zero Speed Switch: A zero speed switch shall be provided to detect loss of motion to the screen assembly. The assembly shall consist of the following items:

   A NEMA 4X probe shall be mounted on the unit to receive signals from ferrous blocks mounted to the inlet head of the screen assembly.

   A NEMA 4X amplifier shall receive the signals from the probe and provide alarm contacts for remote indication. Amplifier shall be mounted on the unit.

   Amplifier requires 115–volt, 60 Hz, single phase power. Proper wiring from the amplifier to the control panel shall be the responsibility of the contractor.

2.3 CONTROLS

One control panel shall be provided and shall house the controls for each screen and wash press and have space inside the panel for the future addition of controls for a forth screen and wash press.

A. A 460–volt UL listed primary control panel shall be provided in a NEMA 4X type 316 stainless steel enclosure suitable for wall mounting. It shall contain the following logic devices for proper operation of the equipment for each of the 2 screens:

   1. Programmable relay to monitor equipment mounted electrical devices to perform necessary logic functions.
   2. Main disconnect switch, with door interlock handle.
   3. Soft starter and overload relay and branch circuit protection for 2.0 HP motor.
   4. Motor starter, Non–reversing, with thermal overload relay and branch circuit protection [AWP, 3HP]
   5. E–Stop Push Button (1)
   6. Control Power Indicating Light. (White)
   7. Motor Hand–Off–Auto Selector Switches (2)
   8. Spray Wash Hand–Off–Auto Selector Switches (4)
   9. Screen Fault Lights. (Amber)
   10. Press Fault Lights. (Amber)
   11. System Reset Push button
   12. Running Lights (Red) (2)
   13. Elapsed Time Meters (4)
   14. Current monitor (4)
   15. Auxiliary Contacts for customer use.

B. A main circuit breaker disconnect switch, motor starters and a step–down transformer shall be provided.

2.4 SEQUENCE OF OPERATION (OVERVIEW)

A. Screenings Unit:

   1. Hand Operation: When HAND mode is selected, the unit will run

continuously. When either spray wash HAND mode is selected, the respective spray wash will run continuously.

2. Automatic Operation: The drive motor and spray washes will be controlled automatically when the selector switches are placed in the AUTO position.

   The unit motor starts after the remote customer start contacts closes. It continues to run until the customer start contact opens, then the unit motor will continue to run for an adjustable time period as per the settings on the off–delay timer.

   The external and internal spray solenoids will cycle per the settings on their own repeat timer whenever the unit motor is running.

3. Emergency Stop: The unit can be stopped at any time by pressing either the control panel mounted, or unit mounted Emergency Stop push buttons. The unit will also be stopped whenever the splash guard is opened (as detected by a splash guard interlock switch).
4. FAULTS.

   a. Excessive motor current will trip the starter overload relays, immediately stop the drive motor. This fault must be reset by depressing the motor starter overload reset internal to the control panel.

   b. Excessive momentary motor current will trip the current monitor and immediately stop the drive motor. Pushing the Overcurrent Reset button will reset this fault.

   c. Loss of signal from zero speed switch/Motion failure switch. Pushing the Overcurrent Reset button will reset this fault.

2.5 CONTRACTOR RESPONSIBILITIES

A. The contractor shall be responsible for reviewing the design of the equipment provided by the manufacturer, so that it fits properly in the structure and interfaces properly with associated equipment provided by others.

B. The contractor shall be responsible for receiving the equipment, unloading it from the common carrier, and storing it safely until it is ready to be installed.

C. The contractor shall install the manufacturer's equipment in accordance with the manufacturer's Equipment Drawings and Installation, Operation and Maintenance instructions.

D. The contractor shall provide all field wiring between the electrical devices on the screen (motors, switches, valves, etc.) and the control panel. Contractor shall also provide all required local disconnects and junction boxes.

E. The contractor shall provide all field piping, fittings, isolation valves, gauges (0 to 100 psi), strainers/filters (at each spray header) and any other components necessary for a complete and functional water spray system, which supplies the required spray water detailed.

PART 3 – EXECUTION

3.1 FACTORY ASSEMBLY, TESTING AND INSPECTION

The equipment shall be factory assembled, operated and inspected prior to shipment to insure the proper interface, and adjustment of all parts. The main control panel shall also be factory tested prior to shipment. Contractor shall install the Drain pan on–site.

3.2 INITIAL START–UP AND TRAINING

A. The contractor shall provide the service of a factory–employed service technician who will adequately inspect the installation, test the equipment furnished under this contract and instruct the owner's operating personnel in its maintenance and operation.

B. The screen and wash press manufacturer shall provide factory service during One (1) trip of two (2) days for inspection of installation, and (1) trip of two days for equipment start up and operator training.

C. The screen shall also be field tested after erection in the presence of the owner and engineer to confirm and verify the structural and mechanical compliance to the specification. The field acceptance test shall include demonstrating that the drum screen operates continuously without vibration, jamming or overheating and performs its specified function satisfactorily.

3.3 INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Five hard copies of the Installation, Operation and Maintenance Manuals are required, a spare manual shall be shipped with the unit to allow for proper operation of equipment prior to release of all final Installation, Operation and Maintenance Manuals to the end user.

A complete electronic O&M manual shall be supplied in addition to the hard copy manuals. This manual shall be electronically searchable. The electronic manual shall be in pdf format.

END OF SECTION 44 43 34

SECTION 44 43 34.1

SCREENING WASHER/COMPACTOR

SECTION 44 43 34.1

SCREENINGS WASHER / COMPACTOR

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The contractor shall furnish three (3) screenings washer compactors, one for each drum screen. The basis of design is around model AWP8–2.0 Aqua WashPress units, as supplied by Parkson Corp., Vernon Hills, IL, or engineer approved equal. The wash press unit shall consist of a Main Body, Screw, Wash Sprays, Flush Sprays, Drive System, Feed Hopper and Covers, Discharge Piping and Controls.

B. The equipment shall be of the latest design and shall be fabricated of the specified materials and in a fashion that shall fully perform the functions described in these specifications.

C. The units shall be supplied by the manufacturer of the Drum Screens to insure uniformity and seamless operation of the equipment.

1.2 REFERENCES STANDARDS

A. The design, manufacture, and installation of this equipment shall meet or exceed the applicable provisions and recommendations of the following current editions of codes and standard authorities, except where otherwise shown or noted:

1. AGMA, American Gear Manufacturers Association
2. ASME, American Society of Mechanical Engineers
3. ASTM, American Society of Testing and Materials
4. ANSI, American National Standards Institute
5. NEC, National Electric Code
6. ABMA, American Bearing Manufacturers Association

1.3 EXPERIENCE

A. The equipment manufacturer shall have a minimum of ten (10) years of design and manufacturing experience with screw wash press units, with not less than one-hundred (100) screw wash press units sold and installed in similar applications in the United States.

1.4 PRE-BID SUBMITTALS

A. The aforementioned screen is the basis of design. Alternative suppliers shall be considered and shall be so named by addendum prior to the bid. In order to be considered as an equal the alternative supplier shall submit to the engineer the following information at least 21 days prior to the advertised bid date. Complete submittal drawings, quality control and product information shall be submitted in electronic and hard copy format, 5 copies required. As a minimum, the following information will be submitted:

1. A Letter of Compliance, which confirms any variances with the Contract Plans and Specifications and provides further explanations where necessary to adequately define the scope of supply.

2. Dimensional plan and section drawings of the equipment mounted in the structure, showing all utility connections and requirements, and anchor bolt locations. Where applicable, drawings will show connection to associated equipment provided by others.

3. Approximate weight of each component or piece of equipment.

4. Manufacturers' catalog information, descriptive literature, specifications, and identifications of material of construction.

5. Power and control wiring diagrams, including terminal layout with numbers, panel construction and panel layout drawings, and control schematics diagrams. Control diagrams will also include a description of operation.

6. Manufacturers' performance data for all drives.

7. Installation, Operation and Maintenance manuals in electronic format for owner's review.

1.5 SPARE PARTS

A. No spare parts are required for the Parkson design equipment. For other pre-approved suppliers, a complete set of brushes, wear strips and spray nozzles shall be supplied.

1.6 BASIS OF DESIGN

A. EQUIPMENT LAYOUT. The contract documents and specifications are based on the Parkson Aqua WashPress Model AWP8-2.0 design. Any changes in layout, access platforms, piping or structural requirements for an alternative manufacturer's design shall be the responsibility of the installing contractor, including the cost of the engineer to verify layout, sizing, and structural requirements.

The unit shall be inclined at 0 degrees from horizontal. The discharge piping shall be designed to direct the screenings from the unit into the designated receptacle or receiving equipment.

B. STANDARD DESIGNS. Where a manufacturer's standard equipment and/or model number is listed, the equipment shall be provided as modified to conform to the performance, function, features, and materials of construction as specified herein.

1.7 PERFORMANCE REQUIREMENTS

A. The unit shall be capable of the following performance:

1. The unit shall be designed to receive and wash screenings, then reduce the volume and water content by means of a pressing action. Screenings to be washed shall be gravity fed to the drainage trough and conveyed by the screw towards the washing section. Wash water is added, which back flows the screenings, while the spiral alternately stops and restarts to convey the screenings through the wash section. The wash water is then turned off and the screenings are discharged and dewatered by the backpressure generated in the discharge pipe.

2. The unit shall be installed outdoors in an unclassified area.

3. The unit's controls shall be installed outdoors in an unclassified.

4. The unit shall be suitable for installation and operation in the designated space.

5. The unit shall have an inlet capacity of 35 cubic feet per hour, handling wet screenings with an approximate dry weight of not less than 8% solids.

6. Utilities

   a. Total Spray wash (max @ 60 psi):15 gpm (Wash water to be filtered to 50 microns by contractor.) See also sections 2.3, C & D.

   b. Power Supply 460 / 3/ 60 (total power demand indicated on Control Panel drawings)

1.8 WARRANTY

A. The equipment warranty shall be for a period of one (1) year from being placed into operation, not to exceed 18 months from the date of delivery. The equipment shall be free from defective material and workmanship, under normal use and service and when installed, operated and maintained in accordance with installation instructions, and maintenance/operating procedures.

PART 2 - PRODUCT

2.1 QUALITY ASSURANCE

A. The equipment shall include all necessary devices, such as machinery guards, emergency stops, warning labels, and similar items.

B. Threaded fitting shall have a standard tapered pipe threads complying with ANSI/ASME B1.20.1.

C. Bearings shall conform to the standards of ABMA.

D. Gear reducer selections shall comply with AGMA standards and gear reducer's recommendations.

E. Nameplates shall be engraved stainless steel and stamped and fastened to the equipment with stainless steel rivets.

F. The equipment shall be manufactured in the United States by a manufacturer that is ISO 9001 certified.

G. The equipment shall be factory assembled and tested for a minimum of one half (1/2) hour at the U.S. factory prior to delivery. The Engineer and/or Owner may witness the factory test, at their own option and expense.

H. The equipment shall be delivered to the site as fully assembled as possible. Some components may be removed from the unit after shop testing to prevent damage during shipment' these components must be re-assembled on the unit by the Contractor.

2.1 MATERIALS OF CONSTRUCTION AND FABRICATION

A. MAIN BODY- The main body shall consist of a drainage trough and a washer barrel, enclosed by an outer housing and a support leg at each end. The main body shall be constructed of type 316 stainless steel for all welded components, to minimize corrosion in the heat affected zones, and type 316 stainless steel for all non-welded components.

B. DRAINAGE TROUGH. The drainage trough shall be the perforated inlet area of the unit, which captures screenings and allows liquid to drain. The inlet area shall measure 11" wide x 27" long. The drainage trough shall be constructed from 12 gauge (0.11") stainless steel with 0.125-inch diameter perforations.

C. WASHER BARREL. The washer barrel shall provide a washing zone and a dewatering zone for the incoming screenings. The washer barrel shall be constructed of 0.25-inch-thick stainless steel, with three distinct perforated drainage zones having 0.125-inch diameter holes chamfered to 0.334-inch diameter on the outside. The inside of the washer barrel shall be provided with six (6) 0.25-inch-thick by 1.50-inch-wide replaceable wear bars with 400 Brinnel hardness.

D. OUTER HOUSING. The outer housing shall enclose the sides and bottom of the drainage trough and washer barrel. The outer housing shall collect drained liquid from the drainage trough and washer barrel and direct the liquid to a 4.0-inch drain tube. Access panels shall be provided on the outer housing in the washer barrel area to facilitate servicing of the washer barrel. The outer housing shall be constructed from 10 gauge (0.135 inch) thick stainless steel.

E. SUPPORT LEGS. A support leg shall be provided at each end of the main body to support the main body, provide the means to mount the drive assembly (at the drive end), and provide the means to mount discharge piping (at the discharge end). Each support leg shall be designed to allow the screw to be removed from either end of the main body. Each support leg shall be provided with a footpad and anchor bolt holes, to secure the unit to the structure.

F. SCREW: The shafted screw shall be provided to convey screenings through the various stages of the unit. The screw shall be constructed of carbon steel and finished with enamel paint. The spiral shall be 8.00 inches OD and have minimum 0.63-inch thick flights. A replaceable 0.25-inch wide nylon brush with a stainless-steel casing shall be attached with bolted clips to the spiral OD throughout the inlet area to scour the perforated sheet. The brush OD shall be 8.50 inches.

WASH SPRAYS

G. The wash zone shall include a spray wash system to wash organic residue from screenings. The wash zone spray shall consist of one (1) spray header, four (4) water injection points, one (1) ball valve and one (1) solenoid valve. The solenoid valve body shall be of Brass construction with Buna seals. The ball valve shall be of brass construction with a stainless-steel ball. The system shall have an output of 10 GPM at 60 psi. The spray connection shall be ½ inch NPT.

H. FLUSH SPRAYS

The press shall include a single point spray wash system to flush organic residue trapped in the outer trough. The flushing spray shall consist of one (1) spray header, one (1) ball valve and one (1) solenoid valve. The solenoid valve body shall be of Brass construction with Buna seals. The ball valve shall be of brass construction with a stainless-steel ball. The system shall have an output of 15 GPM at 60 psi. The spray connection shall be ½ inch NPT.

I. DRIVE SYSTEM- The unit drive system shall consist of a gearmotor mounted on a sealed drive mounting bracket and a drive shaft that connects the gear reducer output to the shaft of the screw.

J. GEARMOTOR. The gearmotor shall be a single speed, dual voltage electric motor direct coupled to an SEW Eurodrive <u>helical</u> gear reducer.

1. The electric motor shall be a 3 horsepower for severe duty motor with a 1.15 service factor, rated for use in a 40° C ambient temperature. The TEFC motor shall be NEMA design A with Class F insulation, 1800 rpm output speed, and a 230/460 volt, 3-phase, 60 Hz power supply. The motor conduit box shall have one (1) 1/2-inch NPT and one (1) 3/4" NPT conduit connection.

2. The helical gear reducer shall be AGMA class II (1.6 service factor) with minimum 94% efficiency, producing an output speed of 14 rpm and an output torque of 13,900 inch-pounds. Heavy duty tapered roller bearings in the gear reducer shall provide a maximum thrust capacity of 6,740 pounds.

   Gear reducers with service factors of less than 1.4 and efficiencies of less than 94% shall not be allowed.

K. DRIVE MOUNTING BRACKET. A drive mounting bracket shall be provided to mount the gearmotor to the drive end support leg of the unit. The bracket shall be made of type 316 stainless steel.

   A compression type packing gland seal shall be provided on the mounting bracket to seal the drive shaft. PTFE packing rings shall be fitted into the seal housing and held in place by a two-bolt stainless steel gland follower.

L. DRIVE SHAFT. The drive shaft will be direct coupled to the spiral and constructed of carbon steel. The shaft will be painted, except in the area of the shaft that extends into the hollow bore of the reducer.

M. INLET HOPPER AND COVER

1. A 12 gauge (0.105 inch) stainless steel inlet hopper shall be supplied to direct screenings and liquid into the drainage trough. The chute shall be flange bolted to the trough, with each side of the chute being a minimum 60 degrees from horizontal.

2. A 12 gauge (0.105 inch) stainless steel cover shall be supplied to cover the remaining top of the main body.

3. A rubber gasket shall be provided to seal the feed hopper and cover

N. DISCHARGE PIPING

1. 14 gauge (.075 inch) stainless steel discharge pipe shall be fitted to the discharge end support leg to direct screenings into a customer provided receptacle. All discharge pipe flanges shall be 304L stainless steel. Aluminum flanges shall not be allowed.

2. The end of the discharge pipe shall be equipped with a bagging device to contain and enclose the pressed screenings. The device shall be fitted with a replaceable magazine of continuous clear plastic hose, 22-inch diameter by 260 feet long, 1.5 mm thick.

O. PIPE SUPPORTS- Pipe supports shall be supplied by the manufacturer.

P. FASTENERS- All fasteners shall be type 18-8 stainless steel.

Q. FABRICATION

1. Weld size, type, and procedure shall provide the necessary strength and facilitate the manufacturing of the specific component.

R. SURFACE FINISH

1. All stainless-steel components shall have standard mill finish and shall be mechanically cleaned to remove weld discoloration and fabrication markings.
2. The screw and drive shaft shall be finished with an enamel coating.
3. The motor and gear reducer shall have the standard manufacturer's finish.

S. ELECTRICAL DEVICES AND CONTROLS Electrical device interconnecting conduit and wiring shall be the responsibility of the installing contractor. In addition to the drive motor, the following electrical devices shall be furnished with the unit:

1. SOLENOID VALVES. Two (2) 120-volt, single phase, 60 Hz solenoid valves for the wash zone and flush spray washes housed in NEMA 4X enclosures shall have 18-inch long integral leads and will have 1/2-inch NPT conduit connections.
2. EMERGENCY STOP. A NEMA 4X polycarbonate emergency stop push button will be mounted to the end flange and shall have a 1/2-inch NPT conduit connection.
3. CONTROL PANEL: A Control Panel shall be provided to control the RDS and AWP. The AWP controls shal be housed in the same panel as the Screen controls.

T. SEQUENCE OF OPERATION (Overview)

1. HAND OPERATION. When HAND mode is selected, the screw will run continuously. When either spray wash HAND mode is selected, the spray wash will run continuously.
2. INTERMITTENT AUTOMATIC OPERATION. The control panel will be equipped to control the wash cycle, screw movement and flush cycle. Each wash or flush cycle and the screw movement will be controlled independently through the use of timers and counters. The drive motor and spray washes will be controlled automatically when the selector switches are placed in the AUTO position.
   a. The press motor starts after an adjustable accumulated run time from the interlocked feeding equipment. The press motor will run for an adjustable length of time, typically set at 0.3 seconds.
   b. The press motor continues to run, and the washing solenoids open for an adjustable length of time, typically set at 3-5 seconds. The press motor stops for an adjustable length of time typically set at 5 seconds.

c. Motor stop/start cycle repeats for an adjustable number of counts, typically set at four (4) to seven (7).

d. The washing solenoids close and the press motor runs for an adjustable length of time, typically set at 13.5 seconds, to dewater and discharge the screenings.

e. The flush solenoid opens for an adjustable length of time after the press motor stops, typically set at 10 seconds. The system will reset after the flush solenoid closes.

3. EMERGENCY STOP. The unit can be deactivated at any time by pressing either the control panel mounted or unit mounted Emergency Stop Safety Tag-Line switch.

4. FAULT CONDITIONS. Motor overload or high motor current conditions will stop the motor and illuminate the fault light.

2.2 CONTRACTOR RESPONSIBILITIES

A. The Contractor shall be responsible for reviewing the design of the equipment provided by the manufacturer, so that it fits properly in the structure and interfaces properly with associated equipment provided by others.

B. The Contractor shall be responsible for receiving the equipment, unloading it from the common carrier, and storing it safely until it is ready to be installed.

C. The Contractor shall install the manufacturer's equipment in accordance with the manufacturer's Installation, Operation and Maintenance instructions.

D. The Contractor shall provide all field wiring between the electrical devices on the screen (motors, switches, valves, etc.) and the control panel. Contractor shall also provide all required local disconnects and junction boxes.

E. The Contractor shall provide all field piping, fittings, isolation valves, and components required to supply the necessary wash water to the spray system (as specified in Paragraph 1.7 A 6 a).

F. The contractor shall be responsible for supplying and installing sixteen (16) 1/2"-13UNC by 5-1/2 inches long type 304 stainless steel expansion anchor bolts.

PART 3 - EXECUTION

3.1 INSPECTION AND STORAGE

A. The equipment shall be shipped assembled and as much as possible (depending on size of unit, drives and supports may be shipped loose). The Contractor shall be responsible for inspecting the equipment upon receipt of goods at the jobsite, unloading, and storing the equipment in a reasonable manner and protecting the motors, gearboxes, and controls from the weather in accordance with the Installation Operation and Maintenance manual.

3.2 INSTALLATION

A. The Contractor shall install the equipment in the structure, according to the Contract Documents and the approved submittals provided by the manufacturer, following the instructions detailed in the Installation Operation and Maintenance manual.

B. Upon completion of installation by the Contractor and startup of the equipment by the manufacturer's field service representative, the equipment will be operated under the supervision of the Contractor for a minimum of eight (8) hours to ensure that all operating characteristics are within acceptable limits.

END OF SECTION

INDEX TO

SECTION 44 44 19 – LIQUID ALUM FEED SYSTEM

SECTION 44 44 19

LIQUID ALUM FEED SYSTEM

PART 1 – GENERAL

1.01 SCOPE

A. There shall be supplied as shown by the plans one (1) complete Liquid Alum Feed System by Burnett, Inc. This proposed system will include alum storage tank., alum feed pumps, tank and pump appurtenances and controls.

1.02 QUALITY ASSURANCE

A. All equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.

B. To insure a consistent high standard of quality, the manufacturer is to comply with storage tank, feed pumps and appurtenances applicable standards mentioned herein.

C. Unit responsibility. Tank and pumps, and all other specified accessories and appurtenances shall be furnished by Burnett, Inc. manufacturer including system warranty.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00.

B. The submittal data shall be prepared, in its entirety, by the equipment manufacturer. Shop drawings prepared by the manufacturer's sales representative, fabrication shop or other than the listed manufacturers shall not be acceptable. No additions or modifications to the manufacturer's submittal will be accepted, with the sole exception of a cover sheet provided by the manufacturer's local representative.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 78 33.

B. Include installation instructions, assembly views, lubrication instructions, and replacement parts lists.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect under provisions of Section 01 65 00.

1.06 SERVICES OF MANUFACTURER

A. Furnish the services of a representative of Burnett, Inc. to assist in adjusting and testing the equipment furnished, to supervise the initial operation, and to make final adjustments as may be necessary to assure the OWNER that the complete system is in satisfactory operating condition.

B. Furnish sufficient supervision, data, and information from the manufacturer to train operators in the proper operation and maintenance of the system furnished.

PART 2 – PRODUCTS

2.01 The Alum Storage Tank

A. Storage Tank shall be one piece molded high density linear polyethylene tank constructed to ASTM D1998 standard, built from all virgin resin with a nominal capacity of 6,500 gallons and a maximum diameter of 10 feet. Tank will have outside level indication on the tank.

1. Tank Appurtenances

a. (1) 24" top access with threaded cover

b. (1) molded calibrated gauge strip

c. (4) molded lift lugs

d. (2) 2" raised face welded flange nozzle (pump suction)

e. (1) 2" raised face welded flange nozzle (Drain)

f. (2) 2" welded HDPE vent

g. (1) 2" raised face welded flange nozzle (Alum Fill)

h. (1) 2" welded full coupling (level sensor)

i. (1) ladder

B. (LCP-1) Alum Control Panel (shared enclosure with proposed Lime Slurry System)

1. All motor starters, relays, timers, and devices for the control and operation of the equipment shall be housed in a control panel provided and shared for both Alum Feed and Lime Slurry Systems.

C. Tank Level Control

1. OMEGA LVU-816 Series ultrasonic level transmitter and controller.

2. Level will display on a Red Lion digital readout located on the door of the Lime Control Panel LCP-LS-1.

D. Feed Pumps

1. Two SoloTech Model 10 positive displacement, peristaltic hose pumps, using lubricated single roller technology and reinforced style hose. (The System Lime/Alum Control Panel and PLC will be designed and pre-wired now for a future third Alum pump to be purchased during Phase II expansion).

2. Feed Pumps shall be a hose pump package with direct coupled gear-motor drive system, TEFC electric motor for operation on 3-phase, 230/460V 60Hz service. Pumps will be controlled by Variable Frequency Drive allowing the pump speed / flow to be controlled though a 4-20 ma signal to the system PLC and to remote operation via Ethernet connection. Remote connection by others.

3. Pumps shall be mounted on a steel base plate and secured to the pump platform of the enclosure.

4. Variable Frequency Drive SMVector shall be mounted in the enclosure.

5. For Burnett Alum System with a System PLC, the pump selector switch placed in Auto, ready to receive an input signal from the remote plant integration system via Ethernet interface provided by the Owner/Contractor. The Burnett Lime and Alum PLC shall send the 4-20 mA corresponding input signal to the feed pump to adjust the speed of the motor via the VFD from 1 to 60 Hz and provide an output signal back to the Burnett Lime Model B Lime System PLC for monitoring.

E. Feed System Accessories

The alum feed system will include the following accessories based on the information provided: Calibration column, y strainer, Back pressure valve, Pressure relief valve, pulsation dampener, and pressure gauge with isolator.

F. The Alum Pump Enclosure

The proposed Alum Pump enclosure is shared with the proposed Lime feed system. Refer to Specification Section 44 44 59 "Lime Slurry System" Paragraph 1.02 – "Feed Pump Enclosure" for details.

G. Valves – All valves shall be true union PVC Ball Valves.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Contractor to install/ provide:

1. Foundations, floor slabs, trenching, grading, grating, and electrical conduit in slab.

2. Grounding for the pump enclosure and tank.

3. All drainage from floor drains.

4. Curbs and containment structures.

5. 480V, 3-Ph, 60 Hz., 60 Amp power to the power panel and terminating in the shared Lime and Alum power panel.

6. Remote signal available via General Contractor provided Ethernet.

7. Service water, pressure not to exceed 70 pounds to the Alum system.

8. All trenching, feed line conduit, open trenching, wall sleeves coring, and tapping and insulation.

9. Heat tracing, if required.

END OF SECTION

INDEX TO

SECTION 44 44 59 – CAUSTIC SODA SYSTEM

SECTION 44 44 59

CAUSTIC SODA SYSTEM

PART 1 – GENERAL

1.01 SCOPE

A. There shall be supplied as shown by the plans one (1) complete Caustic Soda System by Burnett, Inc. This proposed system will include alum storage tank., Caustic feed pumps, tank and pump appurtenances and controls. The Pump and Control System is pre–assembled, and factory tested at our manufacturing facility prior to shipping.

1.02 QUALITY ASSURANCE

A. All equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.

B. To insure a consistent high standard of quality, the manufacturer is to comply with storage tank, feed pumps and appurtenances applicable standards mentioned herein.

C. Unit responsibility. Tank and pumps, and all other specified accessories and appurtenances shall be furnished by Burnett, Inc. manufacturer including system warranty.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00.

B. The submittal data shall be prepared, in its entirety, by the equipment manufacturer. Shop drawings prepared by the manufacturer's sales representative, fabrication shop or other than the listed manufacturers shall not be acceptable. No additions or modifications to the manufacturer's submittal will be accepted, with the sole exception of a cover sheet provided by the manufacturer's local representative.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 78 23.

B. Include installation instructions, assembly views, lubrication instructions, and replacement parts lists.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect under provisions of Section 01 65 00.

1.06 SERVICES OF MANUFACTURER

A. Furnish the services of a representative of Burnett, Inc. to assist in adjusting and testing the equipment furnished, to supervise the initial operation, and to make final adjustments as may be necessary to assure the OWNER that the complete system is in satisfactory operating condition.

B. Furnish sufficient supervision, data, and information from the manufacturer to train operators in the proper operation and maintenance of the system furnished.

C. The Tank will be shipped directly from the manufacturer, received by Burnett in coordination with the Pump and Control Enclosure, and set on the prepared site provided by the Owner.

D. The Pump and Control Enclosure will be transported to the site by our technicians and set into place in conjunction with the storage tank.

E. Burnett's installation and startup technicians will provide all final installation terminations and system extensions.

F. Burnett will provide both startup and technical training for the operators. Specific operational procedures, reporting, and safety training will be the responsibility other Owner.

PART 2 – PRODUCTS

2.01 CAUSTIC SODA TANK

A. Tank shall be single compartment, welded steel reinforced top, having a nominal capacity of 16,000 gallons and a maximum diameter of 12 feet.

B. Tank shall be fabricated using steel as specified by ASTM A36.

C. Tank design shall be in accordance with AWWA D100 with minimum top and bottom plate thickness of ¼–inch and minimum wall plate thickness of 3/16–inch.

D. Tank appurtenances shall be as follows (refer to tank drawings for preliminary orientation):

1. 12–inch mixer mounting nozzle (top)
2. 24–inch atmospheric manhole / inspection port (top)
3. 24–inch manhole (3–1/2 feet above bottom)
4. Two 6–inch nozzle (pump suction, 9–inches above bottom)
5. 3–inch nozzle (drain, 2–inches above bottom)
6. 2–inch nozzle (overflow, 6–inches below top)

7. 2–inch nozzle (vent, top)

8. 6–inch nozzle (level sensor – 18–inches off wall, top)

9. 2–inch nozzle (soda fill, top)
10. Four Anchor lugs
11. Four 10–inch wide by 10 feet long gusseted baffles fabricated from ¼–inch plate positioned 1–inch off the wall
12. Ladder and full tank perimeter handrail (carbon steel)
13. Standoff pipe supports and clamps (maximum 8 feet on center for overflow, and soda lines).
14. Two Lift lugs
15. Soda Fill pipe (2–inch), with quick–connect
16. Overflow Pipe (4–inch)
17. Four 1" anchors furnished and installed by Burnett.

E. Surface Preparation and Painting.

1. The exterior of tank dome, wall, and appurtenances shall be prepared by commercial sandblast followed by one coat of MoPoxYTM High Solids Epoxy Coating 41–series by Tank Manufacturer. Field painting, by General Contractor per specification.

2. Tank Manufacturer shall coat the bottom of the tank with coal tar epoxy: Mo–TarTM C–200 Epoxy Coating.

2.02 FEED PUMP ENCLOSURE

A. The pump enclosure shall be a nominal 10' x 13' metal building with the tank shell forming one wall. The minimum clear height of the enclosure shall be 7'6".

B. The enclosure building shall be stainless steel frame (2" stainless steel) with 3" vinyl backed insulation. The 26-gauge exterior wall panels, roof panels, and flashings shall be coated with a factory finish of MBSC Signature 200 Polar White SR.58, SRI 69 minimum 0.8 mil over a minimum 0.2 Dynaprime PMY0154 primer.

C. The enclosure accessories shall include:

1. One 36–inch by 84–inch access door with hardware.

2. One 1000–watt UL–listed corrosion resistant heater with thermostat/on–off switch. Heater shall be Chromalox Model HVT–2411.

3. One 115–volt corrosion resistant fan having minimum free air capacity of 524 CFM. The fan shall be thermostatically controlled. The fan shall be fitted with a wire guard and removable interior vent door. Provide

manually adjustable, FRP air intake vent with FRP screen. The exhaust fan shall be Dayton Model 1BLH6.

2.03 CONTROLS

2.03.1 (LCP– 1) CAUSTIC AND ALUM CONTROL PANEL

A. All motor starters, relays, timers, and devices for the control and operation of the Caustic and Alum equipment shall be housed in a control panel mounted in the Caustic side of the pump enclosure. A PLC within the Control Panel shall provide remote signal/equipment interface with the plant system via Owner/Contractor provided Ethernet cable.

B. The Burnett B Caustic Soda system with PLC is designed to be a stand–alone, self–contained Caustic delivery system or may be remotely operated from a plant SCADA System via Ethernet cable provided by the Owner/Contractor to the Burnett supplied Allen–Bradley MicroLogix 1400. A list of addresses will be provided to the HMI programmer for status display. Remote input to the Caustic System is necessary for the motor speed (0–100%). This motor speed is generally calculated by the plant's own supervisory PLC/HMI system, based on flow rates, pH, anticipated Caustic needs, etc. as a 0–100% value of motor speed.

C. The Owner/Contractor shall provide a 480V, 60 Amp, 3–phase power feed to the flange mounted circuit breaker located in the Caustic System control panel. A control power transformer with primary and secondary over current protection will be provided.

D. Enclosure: NEMA 4X 304 SS, bottom entry, flange–mounted disconnect. A grounding lug is provided within the panel to assure positive system ground.

E. Components:

1. Circuit Breaker: Isolation Breaker for the Panel shall be a 60 Amp Type M breaker /ITED 43B060L or equal.

2. Starters and Motor protection: Pump motors will be controlled and protected by Allen Bradley Model 100–C and 140M–C2, Type E self – protected manual starters with adjustable amperage breakers. Motor Protection shall conform to IEC Circuit Breaker requirements as defined by IEC 947–2 and UL/CSA listed.

3. Relays: Relays shall be general–purpose control type, 10 amps, 600–volt reversible contacts. Relays shall be equal to Allen–Bradley, Type 700H.

4. Selectors: 30.5 mm, NEMA 4X rated; contacts shall be rated 10 amps continuous, 6 amps breakers at 24 VDC, manufactured by Allen–Bradley, Type 800H.

5. Weatherproof Horn: Horn shall generate a loud audible alarm for high level or mixer failure when activated by 24 VDC power. The horn shall

surface mount with sealable side conduit entry and shall be rated for NEMA 4X. Horn shall be equal to Federal, Model 450E.

6. Indicator Lights: Provide 30.5 mm full voltage type LED indicator lights as equal to Allen–Bradley type 800H for each motor.

   a. Green: Run

   b. Amber: Fault and Low Level

   c. Red: High Level and Reorder

   d. White: Power On

F. Surge Protection: AC power wiring shall be protected against lightning spikes and other transient surges at control panel. Protection shall be as manufactured by Siemens TPS series.

2.03.2 (LIT–1) CAUSTIC TANK LEVEL CONTROL

A. Caustic level control shall be the Milltronics MultiRanger tank level transmitter and indicator. The level indicator will be utilized to produce an audible high-level alarm located on the exterior of the pump enclosure and high level, low level, and re–order indicator lights are located on the exterior of the system control panel. Level signal may be obtained by the plant supervisory system through the Caustic system PLC.

B. Panel Enclosure shall be a polycarbonate enclosure rated NEMA 4X located in the pump enclosure.

C. The level transducer/transmitter shall be a 6" flange mounted Model XPS15 transducer as manufactured by Milltronics.

2.04 TANK MIXER

A. The tank mixer shall be vertical, flange mounted with one axial flow and one radial flow impeller sized and positioned to maintain a homogenous mixture of up to 30% Caustic Soda at ambient temperature. Mixer shall be suitable for operation in a 12' diameter by 19' straight shell atmospheric tank.

B. The motor shall be designed specifically for direct mounting to gear reducer. Motor shall be a TEFC, Frame DRN132 Premium Energy Efficiency, with a severe duty canopy with the following characteristics:

Horsepower: 10 HP

Maximum Speed: 1750 rpm

460 volt, 3–phase, 60 Hz

Continuous Duty

TEFC

C. A local mixer disconnect switch is located within visible sight of the mixer motor and entrance manway to the tank. All tank–mounted conduits shall be Schedule 80 PVC using suitable conduit hubs.

D. The speed reducer shall be designated for mixing service and operation in an outdoor environment.

E. The speed reducer shall be constructed and supported so that the shaft deflection, caused by operation loads, does not affect alignment of the anti–friction bearings or cause misalignment of gearing during mixer operation.

F. All reducer bearings shall be severe duty, anti–friction type, oil or grease–lubricated. The speed reducer shall be splash lubricated, by means of gears or a slinger rotating on a horizontal shaft in an oil bath, to ensure positive displacement of the oil upward for lubrication of critical bearings. A single oil drain shall be provided at the low point of the speed reducer to allow oil drainage and leave a maximum residual of oil of no more than ¼–inch in the drive housing.

G. The shaft and impellers shall be carbon steel. The maximum operating speed of the unit shall be 0.5 times the natural frequency of the shaft and impeller assembly. The shaft diameter shall be determined by an analysis of torque and bending moment as well as critical speed. Minimum shaft diameter shall be 3 inches. The shaft supporting the turbine shall be removable from the speed reducer without disturbing the gears of the speed reducer using a rigid flange coupling on the impeller shaft.

H. The mixer shall be Model LSM 16–30 with motor and gear reducer.

2.05 SODA FEED PUMPS

A. Two SoloTech Model 10 positive displacement, peristaltic hose pumps, using lubricated single roller technology and reinforced style hose.

B. Feed Pumps shall be a hose pump package with direct coupled gear-motor drive system, TEFC electric motor for operation on 3–phase, 230/460V 60Hz service. Pumps will be controlled by Variable Frequency Drive allowing the pump speed / flow to be controlled though a 4–20 ma signal to the system PLC and to remote operation via Ethernet connection. Remote connection by others.

C. Pumps shall be mounted on a steel base plate and secured to the pump platform of the enclosure.

D. Variable Frequency Drive SMVector shall be mounted in the enclosure.

E. For Burnett Caustic Model B Caustic Soda Systems with a System PLC, the pump selector switch placed in Auto, ready to receive an input signal from the remote plant integration system via Ethernet interface provided by the Owner/Contractor. The Burnett Caustic Model B Caustic system PLC shall send the 4–20 mA corresponding input signal to the feed pump to adjust the speed of the motor via the VFD from 1 to 60 Hz and provide an output signal back to the Burnett Caustic Model B Caustic System PLC for monitoring.

2.06 CHEMICAL FEED LINES

The soda feed lines shall be accessible in a PVC conduit (conduit provided by the Owner). The feed tubing to the Feed Point shall be either 1/4", 3/8", 1/2" or 5/8" ID clear flexible reinforced PVC hose (as determined by manufacturer) and shall be equal to Kuri Tec Series #K3150 or Nylobrade®.

2.07 VALVES AND APPURTENANCES

A. Automatic valves shall be actuated 3–way ball valves by Assured Automation.

B. Maintenance valves shall be true union 2–way manual PVC ball valves installed on each side of each pump.

C. Isolation valves for liquid Caustic service shall be 2–inch flanged, pinch valves, ONYX Controls or equal. There is one limit switch on all pinch valves, interlocked in the pump run circuit to assure positive position of the valve for pump protection.

D. Water Meter shall be positive displacement.

Note: The model numbers indicated above are to establish quality and Burnett reserves the right to provide equivalent components in the submission of the approval process.

PART 3 – EXECUTION

3.01 INSTALLATION

All installation shall be in strict compliance with the manufacturer's written instructions. All anchor bolts and other items shall be epoxy drilled and located according to certified prints furnished by the manufacturer, as approved by the Engineer. All electrical connections shall be made in accordance with the National Electric Code (NEC).

3.02 MANUFACTURER'S SERVICE

A. Furnish the services of a factory representative for one, eight–hour day during the installation phase of the equipment. The factor representative will have full knowledge and experience in the installation of the type of equipment being installed.

B. Furnish the services of a factory representative, having complete knowledge of proper operation start–up procedure and maintenance requirements, for one, eight–hour day, to inspect the final installation, supervise a test run of the equipment, and instruct the Owner's personnel in the proper operation of the system.

3.03 MANUFACTURER'S SYSTEM WARRANTY

The manufacturer shall warrant that all supported materials and components will function as specified and be free from defects in manufacturing, design, and fabrication for a period of one year after the system is placed in operation.

Equipment components and accessories manufactured by others but purchased through Burnett Caustic Company, Inc., such as electric motors, valves, and other controls, are guaranteed only to the extent of coverage offered by their original manufacturer.

Expressly excluded from the warranty are defects caused by misuse, abuse, or improper applications, employment, or operation of the unit. The warranty does not cover acts of God, such as, lightning, explosion, fire, and flood or terrorist acts.

This warranty does not extend to damage caused by day–to–day operation considered normal wear items, such as tubes, seats, diaphragm, etc. Equipment, such as tank, mixer, pumps, and associated electrical equipment, is covered under this warranty, and if the equipment requires repair or replacement as a result of ordinary wear and tear under normal conditions, Burnett will repair or replace such equipment as required without cost to the Owner.

Alterations or changes to the Burnett B–2 system and/or soda without approval from Burnett could void the warranty.

THE SODA: The delivered soda concentration will be 30% and the system will feed an established dilution of the delivered concentrate. Strict quality control from the manufacturer is important to the smooth operation of the Burnett B–2 system. Consequently, carbide Caustics and generic slurries may have coarse inert particles that could interrupt chemical feeding.

SODA SPECIFICATIONS: Calcium hydroxide shall be a stabilized 30% aqueous suspension with a Specific Gravity between 1.19 and 1.23 g/ml. The Supplier shall certify no quick Caustic is used in the soda manufacturing process and only finely ground air–classified hydrated Caustic for preparation of the soda product. The soda solids will have 99% or higher passing 100 mesh screen. Soda product must be ANSI/NSF standard 60 certified. Delivery tankers shall be solely used for shipping soda and equipped with a system to avoid spillage during the off–loading. Delivery driver shall be responsible for proper dilution and request inspection by the on–site operator. Generic Caustic slurries can have large particulates that would require costly removal from the system storage tank. The supplier will guarantee the function of the Burnett B–2 Caustic Soda System from storage tank sediment and line stoppage with CAL~FLO® Soda and the prior listed specifications.

The above warranty is in lieu of any other guarantee, either expressed or implied.

Burnett's total liability under any circumstance shall not exceed the original purchase price of the equipment component in question and does not extend to any consequential damages or attorney fees that may result in the need for the replacement of nonconformity components.

3.04 CLEANING

Burnett will clean reactors of all debris prior to testing and start–up and will clean and remove from site all excess construction material brought on–site by Burnett utilized in the installation and start–up of the B–2 system.

3.05 STARTUP

Burnett will conduct a site acceptance test upon the completion of the installation. Tests will be conducted using water as the testing media. The Owner shall be responsible for the providing and disposal of the Water, and the providing of the power from either the permanent or temporary source.

3.06 CONTRACTOR TO INSTALL/ PROVIDE:

A. Foundations, floor slabs, trenching, grading, grating, and electrical conduit in slab.

B. Grounding for the pump enclosure and tank.

C. All drainage from floor drains.

D. Curbs and containment structures.

E. 480V, 3–Ph., 60 Hz., 60 Amp power to the control panel and terminating in the power panel.

F. Ethernet from Plant supervisory system to Caustic/Alum PLC within the system control Panel.

G. All trenching, feed line conduit, open trenching, wall sleeves coring, and tapping.

H. All water for flushing.

I. All insulation required for feed lines, water lines, pipes, tanks or valves.

J. Heat tracing, if required.

K. 1" Service water pressure, not to exceed 70 pounds to the Burnett B–2 Caustic Soda System.

L. Painting of the exterior of the tank dome, sidewall, and appurtenances.

M. The Contractor will clean and remove from site all excess construction material utilized in the installation of the Burnett B–2 Caustic Soda System

END OF SECTION

INDEX TO

SECTION 44 44 73

ULTRAVIOLET DISINFECTION SYSTEM (NON-CONTACT)

SECTION 44 44 73

ULTRAVIOLET DISINFECTION SYSTEM (NON-CONTACT)

PART 1 – GENERAL INFORMATION

1.01 SCOPE OF SUPPLY

A. Manufacturer shall furnish a complete in-line pipe flanged, low pressure high intensity (LPHO) Ultraviolet (UV) Non-Contact disinfection system to provide required disinfection of plant effluent waters prior to ultimate plant discharge.

B. UV systems that require lamps with input power greater than 145 watts shall not be considered. Amalgam lamps shall not be considered, system with quartz sleeve surrounded lamps shall not be considered.

C. The equipment shall essentially be automatic in operation, with no automated cleaning apparatus. Separate cleaning apparatus', integrated wiper mechanisms, quartz sleeves, O-rings, or lifting cranes shall not be required as per of the non-contact UV disinfections system.

D. The system shall be complete with power enclosures, power distribution and system controls shown on the contract drawings and specified herein.

E. Related Work:

1. Section 03 30 00 Cast in place concrete
2. Section 26 05 00 Electrical
3. Section 05 50 00 Metal Fabrications
4. Section 25 50 00 SCADA System

1.02 SUBMITTALS

A. The Manufacturer shall furnish electronic submittals consisting of the following information:

1. Detailed scope of supply
2. Mechanical/ assembly drawings.
3. Power/Control wiring single line diagrams.
4. Manufacturer's catalog information consisting of descriptive literature, specifications and materials of construction for all components

B. After successful startup, Manufacturer shall provide certification that the ultraviolet disinfection system is commissioned and is ready for service.

C. Manufacturer shall furnish the OWNER with three (3) hard copy and electronic copies (CD) of maintenance data on all machinery and equipment furnished for the system. The manuals shall include the following:

1. Equipment operating and maintenance instructions
2. Parts lists
3. Assembly and disassembly instructions
4. Equipment specifications and guaranteed performance data
5. Recommendations for preventive maintenance

6. Step-by-step operating and start-up procedures
7. Lists of spare parts, tools, and supplies
8. Wiring diagrams of all control circuits
9. Software programming as updated after final acceptance
10. Troubleshooting instructions

1.03 QUALITY ASSURANCE

A. Manufacturer's Qualification Requirements:

1. The equipment manufacturer shall be regularly involved in the manufacture and supply of low-pressure high output UV Disinfection systems for a minimum period of ten (10) years, and with a history of at least fifty (50) successful Municipal Wastewater installations of non-contact UV systems.

2. The UV Manufacturer shall submit a Bioassay Validation Report for the proposed reactor conducted and certified by an independent third party. The bioassay protocol, testing, QAQC, data analysis, and report shall be in accordance with the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2012). The bioassay shall have been conducted on an identical UV reactor to the proposed UV reactor, with identical UV lamps, reactor lamp symmetry, and configuration. The UV manufacturer shall demonstrate that the scale up factor from the UV reactor used for bioassay testing to the proposed reactor is less than the maximum allowable scaling ratio. The bioassay report testing shall clearly indicate the proposed reactor(s) ability to meet the specified dose with the number of total UV lamps.

3. The bioassay report shall include evaluations of the reactor performance over varying range of flow per AFP tube, the range of UVT % tested, and the MS-2 Reduction Equivalent Doses calculated per NWRI 2012. The bioassay validation testing must include comprehensively the range of flow, UVT %, and UV MS-2 RED specified for this project. Extrapolations of flow rates, UV Transmittance values, or UV doses outside the range actually tested shall not be permitted for design of the proposed UV system(s).

B. UV Design Criteria:

1. The UV equipment to be supplied and installed shall meet the performance requirement as stated below:

Peak Disinfection Flow Rate- Phase I (Current Phase)	6.0 / 4,167.0	(MGD)/(GPM)
Peak Disinfection Flow Rate- Phase II (Future Phase)	12.0 / 8,133.5	(MGD)/(GPM)
Average Daily Flow- Phase I (Current Phase)	4.0 / 2,777.8	(MGD)/(GPM)
Average Daily Flow - Phase II (Future Phase)	8.0/5,555.6	(MGD)/(GPM)

Peak Hydraulic Flow Rate per UV Train	8.0/5,555.6	(MGD)/(GPM)
Number of UV Trains- Phase I (Current Phase)	2	One Duty- One Standby
Number of UV Trains- Phase II (Future Phase)	1	1 Additional train. Three total two duty, one standby)
UV Transmittance	65.0	% UVT (Minimum)
Total Suspended Solids	< 5.0	mg/l (maximum daily)
BOD*	10.0	mg/l (maximum for single grab sample)
Target Indicator Organism	Fecal Coliform	
Effluent Permit Criteria	23.00	Fecal Coliform Bacteria (count/100mL, Geometric Mean)
Validated MS-2 UV Dose	35	Minimum MS2 UV dose of 35 mJ/cm^2. UV Dose calculated per Independent Third-Party Bioassay conducted in accordance with NWRI 2012- after applying certified-Lamp End Of Lamp Life (EOLL) of 87%, and Fouling Factor of 89%.
End of Lamp Life Factor	.87	Validated by Independent Third party in accordance with NWRI 2012.
Fouling factor (FF)	.89	Validated by Independent Third party
Plant Process	Membrane Bioreactor (MBR)	
Particle Size*	<10	Microns
Total Iron*	0.3	mg/l
Effluent Turbidity*	<2.0	NTU Average

*Note: Industry standard water quality parameters assumed for UV selection based on upstream biological process (MBR).

C. UV Design Dose:

1. Peak Disinfection Flow Rate- 6.0 MGD per UV Train.

a. The UV disinfection system shall be designed to deliver a MS-2 Dose of 35.0 mJ/cm2 under peak disinfection flow and design conditions listed in Section 1.3-B.1, after adjusting for lamp End of Lamp Life (EOLL) and Sleeve Fouling factor (FF). The MS-2 Dose must be verified by the third- party validation bioassay per sections 1.3- A.2, and 1.3-A.3

2. Peak Hydraulic Flow Rate- 8.0 MGD per UV Train.

a. The UV disinfection system shall be designed to deliver a MS-2 Dose of 30.0 mJ/cm^2 under peak hydraulic flow and design conditions listed in Section 1.3-B.1, after adjusting for lamp End of Lamp Life (EOLL) and Sleeve Fouling factor (FF). The MS-2 Dose must be verified by the third-party validation bioassay per sections 1.3-A.2, and 1.3-A.3

3. The UV dose shall be adjusted using an EOLL factor of 0.5 to compensate

for lamp output reduction over the time corresponding to the manufacturer's lamp warranty. A higher EOLL factor shall be allowed only if manufacturer can provide third party verified Microbial testing (testing for EOLL using MS-2) data that has been collected and analyzed in accordance with protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse.

4. The UV dose shall be adjusted using a FF of .5 for contact systems (using quartz sleeves) and non-contact systems. A higher FF shall be considered if manufacturer can provide third party certified report that supports a fouling factor greater than .5, up to a maximum of .9; use of fouling factor greater than .9 shall not be allowed.

D. Head Loss Through UV Reactor(s)

1. Flange to Flange Head loss through each UV reactor shall be as follows:

a. Head loss through UV reactor/ Train < 24.00" at peak hydraulic flow rate of 8.0 MGD per UV Train^

b. Head loss through UV reactor/ Train < 14.00" at peak disinfection flow rate of 6.0 MGD per UV Train^

c. Head loss through UV reactor Train < 7.00" at average daily flow rate of 4.0 MGD per UV Train^

^Note: Headloss through UV reactors measured as difference in water level between effluent level control weir and Water level in influent tank. Because influent tank will be full of water ay peak flows, water level in influent tank may be measured using a 2.00" stand-pipe installed on the influent tank for head loss verification.

E. Operating Conditions:

1. The UV reactor shall be installed indoors, or outdoors with an awning, with ambient temperatures ranging from 35.0 ° F to 110 ° F

2. The UV system shall be designed to operate at a maximum pressure of less than 20 psi. Pumped flow through the UV unit shall require a pressure relief valve for protection against over pressurization/surges and appurtenances for air/vacuum release. The valve(s) to be installed shall be sized by the Manufacturer, reviewed by the engineer and supplied and installed by the CONTRACTOR.

3. The location and placement of the valves shall be as per the engineer's direction.

1.04 EQUIPMENT

A. The Ultraviolet Disinfection (UV) system shall consist of the following components:

1. Reactor Model No: C8t.10082
   a. Designation of reactor Reactors 01, 02 & 03(Phase II)
   b. Number of reactors: 2

2. Each reactor shall consist of the following:
   a. Number of Banks per Reactor: 2
   b. Number of AFP Tubes/ Bank: 80

c. Number of Lamp Racks/ Bank: 9
d. Number of Lamps/ Lamp Rack: 12
e. Number of lamps/ banks: 108
f. Number of Lamps per reactor: 216
g. Total number of ballasts per reactor: 216
h. Air to Liquid Heat Exchangers 4 per UV Bank
i. Cooling Pumps 2 Per UV Reactor
j. Effluent Level Control Weir 2 (1 per UV train)

3. The UV system shall include the following controls/monitoring:
   a. Ultrasonic Level Sensor 2 (1 per UV reactor)
   b. UV Intensity Monitor: 4 (1 per UV bank)
   c. ADR: 8 (2 per UV bank)
   d. EDC: 1 per UV reactor
   e. UV Control Panel: 1 common
   f. UV Master PLC Panel: 1 common
   g. Power Disconnect Panels: 4 (2 per UV bank)

4. The UV system shall include the following instruments:

   a. Bypass Line UV Transmittance Analyzer 1

5. Spare parts consisting of the following:

   a. Spare Ballasts (total 5.0% of all ballasts) 22
   b. Spare Lamps (total 10.0% of all lamps) 44
   c. Lamp Plugs/ Lamp End Connectors (5.0% additional) 22
   d. Proprietary Printed circuit boards (EDC, PIO, LRC Board, MLM, ADR, HUB) 1 each
   e. Proprietary Printed circuit boards
   f. {MLM} (5.0% additional) 5
   g. UV Intensity Sensor- Enaqua part number: 560.6019021
   h. Operator's safety kit includes UV resistant Gloves, and Face Shields that block UV light wavelengths between 200 and 400 nm: 2
   i. AFP Tube Cleaning Kit- Teflon Brush and extension kit with adaptable poles: 2

1.05 WARRANTY

A. PERFORMANCE WARRANTY

1. Manufacturer shall guarantee the specified performance (system shall meet minimum UV doses specified in Section 1.3.C under the conditions specified in the design criteria section) for a period of five (5) calendar years following equipment startup and acceptance to allow evaluation of performance under the specified water quality conditions. The system must be maintained and operated per the manufacturer's recommendations and instructions.
2. If the UV disinfection system fails to meet the performance guarantee criteria or fail to demonstrate performance, the manufacturer shall

modify, change, or add equipment as necessary to meet performance requirements. The manufacturer shall be responsible for any additional costs due to changes (including piping, mechanical, structural or electrical changes) or additional equipment as necessary to meet performance requirements. This includes design, engineering, construction, as well as equipment.

B. EQUIPMENT WARRANTY:

1. GENERAL WARRANTY:

a. The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation, for a period of 2 years which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system).

b. All wiring in the train exposed to UV light shall be warranted for 15 years by the SUPPLIER. If the wiring fails before 15 years have elapsed, the SUPPLIER shall be responsible for the replacement of the wires and the labor.

c. Enaqua shall guarantee that for components manufactured by Enaqua, replacement parts shall continue to be available to the City for a minimum of 20 years from date of successful completion of Initial Performance Test. Enaqua shall guarantee that, if Enaqua or Enaqua's product line is sold, Enaqua shall make provisions such that all guarantees, warrantees, and bonds will remain in effect and that replacement parts and operational support shall continue to be available to the City for the time period specified above.

d. No warrantees shall be pro-rated, and all warrantees shall include all costs associated with required site visits, inspections, equipment removal costs, and equipment installation costs.

e. All warrantees and support shall be provided directly by the SUPPLIER and not the local manufacturer's representative.

2. UV LAMP WARRANTY:

a. UV lamps shall be warranted for a minimum of 16,000 hours operating time under the conditions specified herein non-prorated. In the event of premature UV lamp failure, the UV system supplier shall offer the following:

b. Lamp failure before 16,000 hours – send a replacement lamp free of charge.

c. This guarantee shall be limited by the guaranteed number of start/stop cycles. The guaranteed lamp start/stop cycle shall be 24 stop/start cycles per 24-hour period over the life of the lamp. The automation associated with the UV equipment shall be programmed to prevent more than 24 start/stop cycles per day. Additionally, the automation system must log the operational hours for each individual lamp.

d. The guaranteed lamp life shall not include periods when the plant is not in operation and/or when the UV system is shut down.

e. SUPPLIER shall ensure all returned UV lamps (old/new) are recycled upon receipt of the returned lamps at the manufacturing headquarters for the life of the UV Disinfection System (20 years after successful completion of the Initial Performance Test).

3. UV BALLAST WARRANTY:

a. SUPPLIER shall guarantee all ballasts against failure for a minimum period of 10 years, which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system).

b. SUPPLIER shall replace any ballast that fails before the end of the designated warranty period at no cost to the City, with freight and insurance paid by SUPPLIER. Installation of the failed ballast can be performed by City.

4. AFP TUBE WARRANTY:

a. AFP tubes shall be warranted for twenty years as long as the wastewater flow and quality remain in the range(s) specified in the Design Criteria, and the UV system is operated in accordance with the O&M manual.

5. UV SENSOR WARRANTY:

a. UV sensors shall be guaranteed against failure for a minimum of five (5) years.

1.06 ACCEPTABLE MANUFACTURERS

A. The equipment manufacturer shall be regularly involved in the manufacture and supply of low-pressure high output UV Disinfection systems for a minimum period of ten (10) years, and with a history of at least fifty (50) successful Municipal Wastewater installations of non-contact UV systems.

B. Basis of Design for non-contact UV disinfection system and components shall be equipment manufactured and supplied by Enaqua, 2410 Birch Street, Vista, CA. All alternate manufacturers must be pre-qualified a minimum of 30 days prior to bid and must meet all performance, warranty, control and experience criteria.

1. Alternate equipment for the Basis of Design may be accepted for consideration if Seller of alternate equipment (Seller) adequately demonstrates to Buyer, at Buyer's sole discretion, that:

   a. The proposed alternate equipment shall be equal to the Basis of Design equipment and shall meet the design and performance criteria described herein, have the same warranty, shall maintain compliance of wastewater treatment plant discharge permit(s), rules, and regulations, and not result in any adverse impacts on OWNER, including, but not limited to, additional capital or operational costs.
   b. Seller shall indemnify buyer from any and all patent infringement claims that may arise from the purchase of seller's equipment.
   c. Seller shall pay all costs to Buyer to re-design and re-schedule the Project and revise the Bid and Contract Documents as necessary for the incorporation of the proposed alternate equipment.
   d. Seller shall provide documentation showing compliance with all sections of this specification at time of bid.

PART 2 - PRODUCTS

2.01 DESIGN, CONSTRUCTION AND MATERIALS

A. General

1. All module welded metal components in contact with effluent shall be Type 316 stainless steel.
2. All non-wetted metal components shall be Type 304 stainless steel with the exception of the Lamp Rack Assembly, which shall be constructed of aluminum and be capable of sustaining intermittent pedestrian traffic on the lamp racks.
3. All wiring exposed to UV light within the UV reactor, or electrical ballast enclosure shall be Teflon™ coated.
4. All wires connecting the lamps to the ballasts shall be enclosed inside the frame of lamp rack and not exposed to the effluent.
5. The effluent water shall be conveyed through the UV reactor via AFP_{840}™ tubes – there shall be no contact with effluent and quartz sleeves at any time during normal operation.
6. All wetted components in the UV reactor shall be: AFP_{840}™, 316 SS, PVC, ABS or other non-reactive, non-corrosive material.
7. The UV system (ballasts, lamps, and controls) shall be capable of 24 on/off cycles per 24-hour day for the full specified warranty life of the lamps and ballasts.

B. Lamp Array Configuration:

1. The lamp array configuration shall be the uniform array with all lamps parallel to each other and to the flow.
2. The UV reactor shall be designed to avoid any immersion of UV lamps in the Effluent.

3. The UV lamps shall be arranged around the outside of the AFP840™ tubes in such a way that each AFP840™ tube shall have no less than 6 lamps irradiating it at all times.
4. Reflectors optimized to reflect UVC wavelength of 253.7 nm and improve UVC energy density within the UV reactor shall be arranged in between the UV lamps in the lamp racks such that each AFP840™ tube reactor has a minimum of six (6) UV lamps and four (4) reflectors surrounding it.

C. Inlet/Outlet Flow Distribution:

1. Each UV reactor shall have an inlet and outlet tank. Plant effluent piping shall connect to each of the tanks to convey effluent through the UV reactor.
2. Connection to inlet and outlet tanks of UV reactor: Diameter: 24.00" Diameter (ASME/ANSI B16.5, CL 150 Flange)
3. Each UV reactor shall have a flow distribution sheet, so as to distribute wastewater efficiently through the AFP_{840}™ tubes.
4. The effluent tanks of the UV reactors shall have a flat weir installed to ensure minimum submergence of the AFP tubes under all flow conditions. The Flat weir shall be made of 304 SS and fabricated as an integral part of the discharge tanks.
5. The tanks and inlet flow distribution sheet shall be made of 304SS material. All material which comes in contact with the wastewater shall be non-corrosive.

D. Effluent Level Control:

1. Each UV reactor shall have effluent level control mechanism installed in the effluent tank. The weir plate shall be a rectangular flat weir. The weir geometry shall be designed such that the weir will flood varying # of AFP tubes based on flow thus achieving the required minimum submergence of the calculated # of AFP tubes and providing the minimum specified UV dose at varying flow conditions listed in 1.3.B.1.
2. The effluent level control shall be a removable rectangular flat weir plate, and a weir frame to mount the weir in the effluent tank of each UV reactor. The rectangular flat weir plates and all mounting hardware shall be of 316 SS, to be prefabricated and installed by manufacturer prior to shipment of UV reactor from factory.

E. AFP_{840}™ Tube Ultraviolet reactor:

1. Within the ultraviolet reactor, AFP_{840}™ UV transmitting tubes are arranged in a horizontal and vertical array. These AFP_{840}™ tubes are in a parallel mode and are attached at one end to the inlet flow distributor sheet and to the outlet flow distributor sheet with appropriate leak proof fittings. The AFP_{840}™ tubes shall be adequately supported.
2. In between and around the AFP_{840}™ tubes, lamp rack assemblies shall be placed in such a fashion so as to provide uniform and adequate ultraviolet light intensity. The lamp racks slide in and out between and around a row of AFP_{840}™ tube array.
3. Within the AFP_{840}™ UV reactor, all UV sensitive materials shall be protected from the UV light.

4. The flow path through the AFP_{840}™ tubes shall achieve optimized plug flow regime. The flow of wastewater should be in sufficient turbulent mode; therefore, the Reynold's number in each UV reactor would be greater than 50,000 at peak flow. A turbulent flow shall be in such a way that it scours the inner walls of the AFP_{840}™ tube to help prevent scaling or fouling.
5. The UV reactor shall be covered from five sides with either coated aluminum or stainless panels. The sixth side (top) shall have access door(s). The lamp racks shall be accessible through these doors.
6. The air temperature inside the AFP_{840}™ UV reactor shall be maintained between 90-120 deg. F by means of an air-air heat exchanger to minimize the potential for increase in the temperature of the disinfected effluent. The control of the reactor temperature shall ensure optimum UV light emissions from the UV lamp.
7. A temperature sensor shall be installed within the UV reactor for protection against heat build-up under no or low flow conditions.

F. UV Reactor Cooling System:

1. Cooling within the UV reactor shall utilize a series of air to water heat exchangers. The primary cooling water shall consist of disinfected effluent obtained downstream of the UV reactor via a centrifugal pump.
2. The UV equipment manufacturer shall supply the submersible cooling pumps and associated controls.
3. Control between the cooling water pump shall be done via a flow-switch located on the downstream end of the reactor.
4. Submersible Cooling Pumps
5. Two cooling pumps shall be supplied per UV reactor, one duty and one backup.
   a. The submersible cooling pumps shall be ITT GOULDS submersible Pump Model 1DW51D4EA.
   b. The design point of the pump shall be 20 gpm at 35 feet TDH with a rated power of 0.75 hp. Power to the pump shall be 460 V, 3 PH.

G. UV Lamps: The UV lamps shall have the following characteristics:

1. A low pressure, high output (LPHO) non-amalgam mercury vapor lamp of the hot cathode type.
2. The filament shall be of the clamped design, significantly rugged to withstand shock and vibration.
3. Each lamp will produce at least 90% emissions at the germicidal frequency of 253.7 (254nm) nanometers.
4. The power consumption shall be a maximum of 138 input watts per lamp, total including ballasts losses shall not exceed 145 watts including ballast losses. The rated UV output at 253.7 nanometers (nm) shall be a nominal 57 UVC Watts at 100 hours of operation.
5. The lamp shall have a minimum UV intensity of >400 microwatts/cm^2 at 1 meter.
6. Each lamp shall have a rated life of 12,000 hours.
7. Each lamp shall be single ended. Each lamp shall have a nominal arc length of 1400 millimeter.
8. Each lamp has a minimum length of 1554 mm.
9. Each lamp shall produce no measurable amount of ozone.

10. Each lamp envelope is made of fused quartz and is capable of transmitting at 90% of UV light at 253.7 nm.
11. Electrical connections shall be at one end of the lamp and have six (6) pins, dielectrically tested for 2,500 volts. Lamps that have 2-4 pins (instant start) may be considered. However, to be considered as an alternate, instant start lamp systems shall supply replacement spare lamps equal to 20% of the total number of lamps in the system.
12. Each UV lamp shall have a smart lamp Module (an integral unique lamp identification chip) embedded in the lamp pin connector that enables the lamp position in the UV reactor to be altered independent of a lamp holder. The smart lamp module shall be capable of measuring and storing at a minimum the following data for each UV lamp in a reactor:

    a. Part and Serial number (unique identification) of each individual UV lamp
    b. Total accrued run time hours
    c. Lamp ON/OFF cycles

H. UV Lamp Racks

1. The UV lamp racks shall be placed between rows of the AFP_{840}™ tubes.
2. The lamp racks shall typically slide in and out within a track that shall be attached to the main frame of the UV reactor.
3. The use of cranes, hoists or other mechanical lifting devices shall not be required.
4. The lamp rack assemblies shall be made from aluminum.
5. Electrical mounting sockets shall be attached to one end of the lamp rack.
6. The other end of the rack shall have slotted holes to slide lamps in and out during installation and removal of lamps.
7. Reflectors optimized to reflect UVC wavelength of 253.7 nm and improve UVC energy density within the UV reactor shall be arranged in between the UV lamps in the lamp racks such that each AFP840™ tube reactor has a minimum of six (6) UV lamps and four (4) reflectors surrounding it.
8. Quick power disconnects allow quick disconnect of the lamp rack assembly to the main power at the UV reactor chassis.
9. Each lamp rack shall be equipped with its own on/off switch and fuse.
10. Each lamp rack shall be equipped with an LED indicator to identify the operating condition of each lamp on the lamp rack.
11. Lamp Racks shall be removable for service during UV operation without impacting Hydraulic flow and still maintaining plug flow regime in the reactor.
12. Each lamp shall be controlled by an individual ballast. Systems that have one ballast controlling multiple lamps shall not be considered.
13. There shall be no quartz sleeves, O rings, seals, glands or retainers required to be around the lamps when installed in the lamp racks.

I. Electronic Ballasts:

1. The ballast used to energize the UV lamps shall be high frequency electronic ballasts. The ballasts shall be housed in the lamp rack assembly as an integral part of the lamp rack.
2. The electronic ballasts shall be rated at 120-277 V +/- 10% without discernible change of characteristics.
3. The electronics ballast shall have the following features:

   a. Power factor greater than or equal to 0.95.
   b. Electrical conversion efficiency greater than or equal to 90%.
   c. Ballast shall have high frequency phase returns from the UV lamps.
   d. The ballast operating frequency shall be between 40 and 150 K Hz.
   e. The ballast shall have a thermal overload protector to protect against overheating when ballast skin temperature reaches 75 deg. C.

J. Automatic Level Control Devices. Not used

K. UV Intensity Monitor

1. The UV reactor shall have a minimum of one UV intensity sensor which responds to the germicidal portion of light generated. The sensor shall not degrade after prolonged exposure to the UV light or effluent.
2. The sensor shall measure only the germicidal portion of the light emitted by the UV lamps as measured at 254 nm. It shall have sensitivity at 254 nm of greater than 95%. Sensors whose sensitivity to other wavelengths amounts to more than 5% of the total sensitivity shall not be allowed.

L. Ultrasonic Level Sensor

1. The inlet each reactor shall include an ultrasonic level sensors and transmitter provided by Manufacturer of the non-contact UV disinfection equipment, which will monitor the water level in the inlet box and transmit a signal to the EDC for activation and de-activation of UV lamps based on the level in the channel.
2. The ultrasonic level sensor/transmitter shall conform to the following requirements:

   i. Range: 8" to 16'-0"
   ii. Accuracy: $\pm$ 2% of span in air
   iii. Resolution: 0.039"
   iv. Beam width: 3"
   v. Dead band: 8"
   vi. Display tube: Six-digit LCD, using units of inches, centimeters, or percent
   vii. Display mode: Liquid height
   viii. Memory: Non-volatile
   ix. Supply voltage: 12 – 28 VDC
   x. Loop resistance: 500 ohms at 24 VDC
   xi. Signal invert: 4-20 mA
   xii. Calibration: Push button
   xiii. Fail-safety: Selectable 4 mA
   xiv. Process temp: -7^{0}F to 140^{0}F
   xv. Electronics temp.: -40^{0}F to 160^{0}F

xvi. Pressure: 30 psi @ 25^{0}C, derated at 1.667 psi per ^{0}C above 25^{0}C
xvii. Enclosure rating: NEMA 4X (IP65)
xviii. Enclosure vent: Watertight membrane
xix. Enclosure: PC/ABS FR
xx. Trans. Material: PVDF
xxi. Process mount: 2" NPT
xxii. Mount gasket :Viton
xxiii. Conduit entrance : Dual, 1.2" NPT
xxiv. Classification : General purpose
xxv. CE compliance : EN 61326 EMC

3. The ultrasonic level sensor/transmitters shall be EchoSpan Ultrasonic Level Transmitter Model LU81 or approved equal.
4. The ultrasonic level sensor/transmitter(s) shall be mounted atop a section of PVC pipe securely mounted vertically to the inlet tank and extending to within twelve inches (12") of the bottom of the inlet tank. The vertical pipe shall serve as a stilling basin for the ultrasonic level sensor transmitter and prevent false or no readings caused by water turbulence in the inlet tube sheets by inflows.

M. Bypass UV Transmittance Sensor and Controller

1. One (1) bypass UVT% sensor and controller shall be supplied by Enaqua and installed by contractor at location designated by the engineer on project drawings.
2. UVT Sensor shall be REALTECH REALUV M3000, with an automated pumping and cleaning system; REAL PUMP CLEAN SYSTEM I- or approved equal.

N. Electrical:

1. The UV reactor shall be powered from its own incoming power supply (to be supplied by others).
2. All cabling, conduit runs and wiring from the plant power supply to the UV reactor shall be as shown on the construction drawings.
3. The CONTRACTOR shall be responsible for bringing main and control power to the UV reactor through a Branch Circuit protections device (disconnect) as shown on the drawings.
4. Electrical power required shall consist of the following:

   a. Lamp power to reactor(s): 480 VAC, 3 phase, 4 wire plus ground
   b. Control power to reactor(s): 120 VAC, 1 phase, 2 wire plus ground
   c. Power to cooling pumps: 480 VAC, 3 phase, 3 wire plus ground
   d. Heat Exchanger power to reactor(s): 120 VAC, 1 phase, 2 wire plus ground
   e. Power to UV Control Panel: 120 VAC, 1 phase, 2 wire plus ground
   f. Power to UV Master PLC Panel: 120 VAC, 1 phase, 2 wire plus ground
   g. Power for UVT Analyzer: 120 VAC, 1 phase, 2 wire plus ground

O. UV Power Panel Enclosures:

1. The power panel enclosures) for the UV banks, and pump panels, shall

consist of a UL 508-A NEMA 4X type 316 SS rated electrical enclosure. The power panel shall house the following:

a. All contactors, disconnects, terminations and fuses required to power the appropriate bank.
b. Electrical safety lock-out.

2.02 CONTROLS AND INTEGRATION

A. UV CONTROL SYSTEM - Electronic Data Center (EDC)

1. Each UV reactor shall be equipped with a supervisory microcontroller called Electronic Data Center (EDC). The EDC shall collect all the data from individual UV lamps, UV and other sensors in the system and shall display it at the HMI and remotely to the plant operation console. The Local display panel (HMI) shall display at a minimum the following data:

a. UV Reactor in Duty/Stand-By
   i. HAND, AUTO or REMOTE modes

b. ON/OFF status of lamps.
c. Water level (depth) in UV inlet tanks.
d. Error Status of lamps and sensors.
e. Individual Lamp Hours for each UV Reactor and Bank
f. An advanced signal for lamp service or replacement.
g. Flow through UV system (in MGD/GPM)
h. UV intensity for the Active UV Banks
i. UV Transmittance % measured by UVT sensor
j. Delivered UV dose in mJ/cm^2
k. The type and location of the alarm.
l. The frequency of alarms shall be counted and stored.
m. Alarms and historical operating data shall be stored in a removable storage device in comma delineated format.

2. Communication between each UV rector and EDC's shall be via CAT5 or CAT 6 Ethernet cable.

3. Integration of alarms between the EDC's and Travis Field WRF's SCADA system PLC shall be via Modbus TCP/IP. Communication between the UV Control Panel and the plant PLC shall be via CAT6 Ethernet cable. A unique IP address to be assigned to each EDC by plant SCADA integrator during installation and integration phase.

a. All registers of the EDC shall be available to the plant's SCADA system PLC

B. UV CONTROL SYSTEM- Local Display Panel (HMI)

1. The HMI for Enaqua's EDC's shall be installed and mounted in UL 508-A NEMA 4X type 316 SS rated electrical enclosure to provide graphic interface for monitoring and control.

2. The HMI interface shall be 19" NEMA 4X Touchscreen Industrial Display (Hope Industries Model HIS-ML19 (Rev. G)) with VIA Technologies Windows 10 PC AMOS-3005-1Q12A2), and shall display all system operational data, system operational history and shall allow access via remote internet connection for troubleshooting and system upgrades.

   a. The UV Control System enclosure shall house the following components:

      i. 19-inch color touchscreen display
      ii. Windows 10 PC
      iii. Ethernet Switch, 8 port 10/100BaseT(X) (RJ45 connector. Weidmuller Model IE-SW-BL08-8TX
      iv. Electronic Data Center's (EDC) EDC GEN 2- Part # 62.010037
      v. PIO (Enaqua I/O Modules). Part # 062.01003600
      vi. 24 V DC Power Supply. IDEC Slim Line Model PS5R-SB24
      vii. 600 VAC UPS. Allen Bradley MODEL 1609-B600N

   b. There shall be a three-way HOA control for each UV reactor allowing OFF, HAND, or AUTO (automatic) operation of the reactor providing control for the following;
      HAND: Shall provide local lamp control.
      OFF: Shall power off the lamps in the reactor.
      AUTO: Shall provide automatic lamp control from remote signal.

C. ALARMING AND CONTROLS:

1. Minor alarms shall be provided by each EDC via MODBUS TCP to plant's SCADA system to indicate to plant operators that maintenance attention is required. Alarms shall include:

   a. Low UV Intensity shall be pre-set at the factory for 70% of the intensity after 100 hours. Alarm set point shall be field adjustable.
   b. # Lamp Out
   c. Lamp Life approaching EOLL

2. Major alarms shall be provided each EDC via MODBUS TCP to plant's SCADA to indicate an extreme alarm condition in which the disinfection performance may be jeopardized. Alarms shall include:

   a. Low UV Intensity Alarm. This alarm shall be pre-set at the factory for 50% of the intensity after 100 hours burn-in of the lamps. The alarm set point shall be field adjustable. A low intensity alarm shall not cause any bank to turn off.
   b. Low UVT Alarm. Field settable, set at 65.0 at factory
   c. Low dose alarm. A low dose alarm shall be generated when the delivered calculated UV dose is below UV dose specified
   d. High flow alarm: A high alarm shall be generated when the flow in MGD approaches the peak design flow rate of the UV system.
   e. Adjacent lamp failure alarm
   f. Lamp rack power failure
   g. Master alarm

D. REMOTE MONITORING AND CONTROL:

1. The Run command for each UV reactor hard-wired connections from the Main Plant's PLC to PIO (Discrete Input module) for each EDC. The UV reactors can be turned on or off as required by the Main Plant's PLC/SCADA system by opening or closing dry contacts.

   a. With the switches for each UV Bank in the AUTO position, the reactors shall be controlled externally from the Enaqua HMI panel.
   b. Local control (on UV Control Panel): The switches shall override the control from HMI panel.
   c. Remote Start: Each UV reactor shall have the capability of remote start via dry contact from Main Plant's PLC.

2. The UV reactor shall have the capability of providing basic remote monitoring/control via the plants main console (or other designated computer). The plant shall provide either an Internet IP address specific to the UV system, or allow access through its network and via secure website.
3. Connection/integration of each EDC to Main Plant's PLC or SCADA system shall be via MODBUS TCP

E. UV CONTROL PHILOSOPHY

1. An outline of the appropriate number of UV trains, and banks required to meet the specified minimum UV dose is as follows:

   a. **Flow Pacing of UV Trains:**
      i. In Phase I both UV Reactors (UV-1 and UV-2) shall be online at all times for varying flows. Plant operators shall place the selector switch for the UV reactors in AUTO position, and after a 5-minute delay open the inlet isolation valve to the UV reactors.
      ii. Depending on total flow to the UV system, the UV Control system shall be programmed to perform flow pacing of the two UV reactor Banks in each UV reactor as follows:
      iii. When plant influent flow consistently reaches 90% of the disinfection capacity of two UV Banks (UV-1 Bank 1 & UV-2 Bank 1) of 6.0 MGD (5.4 MGD/3,750.0.0 GPM); the UV Control system shall activate two additional UV Banks (UV-1 Bank 2 & UV-2 Bank 2)
         1. If after a duration of 30 minutes the effluent flow has not increased > 3,750.0 GPM, the UV control system shall inactivate UV Banks (UV-1 Bank 2 & UV-2 Bank)

      iv. Flow pacing on falling flows shall follow the same pacing regime in reverse order after both UV reactors are online and the plant effluent flow drops below 4,167.0GPM.

b. **Level Pacing (UV Dose Pacing) of UV Reactors:**

i. Within each UV train the effluent rectangular flat weir shall control the level of water in the UV reactors based on flow. The Weir geometry has been designed to ensure that the minimum # of AFP tube required to be flooded downstream of the UV reactor at varying rows to deliver the minimum MS-2 UV dose specified (35.0 mJ/cm^2) at the minimum UVT% (65.0%), are flooded.

ii. This function is called controlled Level Pacing, wherein only the # of AFP tubes necessary to provide UV dose of 35.0 mJ/cm^2 based on flow and the specified minimum UVT% are flooded by the geometry and weir crest of the effluent weir. The associated UV lamps in each lamp rack of each UV bank, based on level of water in the channels are active, and the rest of the UV lamps are OFF. Level pacing of the UV lamps in the lamp racks of each UV bank is controlled by the EDC.

2. Using flow and level pacing, the UV system is designed to deliver a minimum UV dose of 35.00 mJ/cm^2 MS-2 RED under all flow and water quality parameters listed in Section 1.3.B & C.

3. The UV control system design shall allow operation of the UV system in either manual (HAND) or automatic (AUTO) modes.

4. UV reactor alternation: The alternation of the two UV trains and four banks UV banks shall be performed manually by plant operators ensure equalized operating hours of both UV reactors.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Installation of the UV equipment shall be by the Contractor in accordance with the Installation Contract Documents, and SUPPLIER's engineering drawings and instructions. SUPPLIER shall supervise the installation of the UV equipment. The Contractor, in accordance with the Installation Contract Documents and the SUPPLIER's engineering drawings and instructions, shall install the equipment provided by the SUPPLIER under the UV Disinfection Equipment System Proposal.

3.02 FIELD EQUIPMENT CHECKS

A. Equipment Checks: Prior to the Field Testing (as detailed below, including Hydraulic and Alarm Testing, Initial Performance Test, and other testing), the SUPPLIER shall check that all equipment is installed properly, and functions as specified herein. The equipment checks shall include, but not be limited to:

1. Proper installation and alignment of UV support structure defined as the trains containing the UV banks and associated mounting brackets.

2. Water tightness of all submerged equipment.
3. Proper placement of UV lamp banks to assure specified water levels relative to the lamps.
4. Electrical wiring and connections.
5. Proper operation of instrumentation, alarms, and operating indicators associated with the UV equipment.
6. Proper placement and operation of lamp driver/ballast and other equipment in the control panels.
7. Adequate ventilation in the control panels.
8. Proper operation of lamp bank shutoff switches and ground fault circuit interrupters.

B. Upon completion of equipment checks, the SUPPLIER shall submit to the City written certification that all UV equipment and accessory equipment associated with the UV disinfection system have been properly installed, are in good condition, are functioning properly, and are in accordance with the Installation Contract Documents.

3.03 FACTORY ACCEPTANCE TESTING

A. The UV disinfection system specified herein shall be factory assembled, and factory tested to the largest extent possible, complete with all components specified.

3.04 FIELD TESTING

A. Following the SUPPLIER's calibration of instruments, the SUPPLIER shall perform Component, System, and Operational Tests on the UV Disinfection Equipment System. It is the responsibility of the SUPPLIER and Contractor to jointly coordinate and arrange the times for testing and startup activities; however, the Contractor must confirm that these times are acceptable to the City.

C. Calibration:

1. Approximately 60 days prior to the Initial Performance Test, the SUPPLIER shall calibrate all instrumentation associated with the performance testing.
2. If retesting is required, the SUPPLIER shall recalibrate instruments associated with the retest if they have not been calibrated within the previous 60 days and submit that information to the Engineer prior to retesting.

D. Data Collection:

1. Direct readings from the instruments shall be used in the calculations to determine conformance with the guaranteed performance requirements.
2. Readings shall be obtained from digital trends from the UV Disinfection Equipment System PLCs and by manually recording the values directly from the instrument.
3. Record (and round if necessary) to the level of accuracy of the instrument before any calculations.
4. Collect manual instrument readings at 4-hour intervals during the Initial Performance Test and at 1-hour intervals during the Average Power Consumption Test.

5. There shall be no adjustment to readings or calculations due to random or systematic instrumentation error or accuracy limitations.
6. The SUPPLIER shall document all modifications, changes, or additions and amend the operations and maintenance manuals and record drawings to reflect the modifications.
7. All modifications required as a result of Initial Performance Test failure must be completed within 90 days of the start of the original testing period.

E. Retesting: The SUPPLIER shall be responsible for all retesting. SUPPLIER shall recalibrate all instrumentation associated with the retest in accordance with this Section, if the instrumentation has not been calibrated within the 60 days immediately prior to the retest.

3.05 HYDRAULIC AND ALARM TESTING

A. After the City accepts the SUPPLIER's written certification of proper installation of the UV Disinfection System as specified herein, the HYDRAULIC AND ALARM TESTING shall be performed to determine whether or not the equipment meets the hydraulic and alarm conditions specified herein. HYDRAULIC AND ALARM TESTING protocol shall be submitted to the Engineer for approval a minimum of 30 days prior to the scheduled UV system startup:

1. Headloss Tests: Headloss through one train shall be measured and plotted on a curve showing flow rate in MGD on the horizontal axis and headloss in inches of water on the vertical axis. The level upstream of the first bank of lamps and the level downstream of the last bank of lamps shall be used to verify the estimated train headloss specified by the Supplier in Form 1 of this Section. A minimum of five headloss measurements shall be taken during this test at approximately 25, 50, 75, 100 and 120 percent of the design peak flow rate per train.
2. Alarm testing shall include simulation of flow and water quality change, lamp and bank failures, sensor performance alarms and the proper maintenance of the minimum UV dose over a range of flow and water quality conditions, in accordance with this specification.

3.06 INITIAL PERFORMANCE TEST

A. Following completion of the ALARM AND HYDRAULIC TESTING and calibration of all instruments, the SUPPLIER and the Contractor shall conduct the INITIAL PERFORMANCE TEST (IPT). The IPT shall be conducted to determine whether or not the equipment meets the Performance Test Requirements specified herein.

B. The SUPPLIER and the Contractor shall provide the IPT Report within 10 working days of completion of the test period.

C. To perform the test, the SUPPLIER and the Contractor shall operate the system continuously over a 5-day test period, and collect and summarize data to demonstrate that the system meets the following Performance Test Requirements:

1. Net Production Capacity: System meets average daily flow and peak flow rate requirements as defined in this specification.

2. Minimum Design Dose: System can deliver the minimum design UV dose as defined in this specification.
3. UV Disinfected Effluent Water Quality: UV Disinfection system produces an effluent in complete compliance with requirements as specified in this specification.
4. Cleaning: The on-line, automatic cleaning system cleans the lamps as thoroughly and frequently as is required for the system to deliver the minimum design dose at all times. The cleaning system maintains the Sleeve Fouling Factor.
5. Chemical Cleaning: one UV bank shall be chemically cleaned at the end of the IPT period. This cleaning shall restore the UV sleeves to its state of cleanliness at the onset of the IPT test. This shall be quantified by comparing the UV intensity measured at this bank at the onset of the IPT testing and after the chemical cleaning and adjusting for ambient UVT.
6. No major changes in equipment or apparatus will be permitted during this test period. However, minor adjustments of equipment that would normally be expected during regular operation of the equipment in plant use may be made.

F. SUPPLIER shall submit a detailed protocol to be followed for the IPT at least21 days in advance. The protocol shall include the proposed laboratory to analyze the IPT samples. The protocol and laboratory require written approval by the City before initiating the tests. The protocol shall specifically detail the operational mode of the system, sampling program, method and schedule, equipment and system monitoring data to be collected with each sampling, the daily (manual) log format, and all sampling and analytical procedures. Upon acceptance of the protocol by the City, the SUPPLIER shall commence the performance test. The SUPPLIER shall collect and process influent and effluent samples 2 times per day and test for turbidity, influent, and effluent Total Coliform, and transmittance for the test period.

G. Successful completion of the IPT shall be defined as continuous operation over the IPT test period without a major failure in the system and demonstration that system meets all performance requirements established herein. Downtime resulting from City's operation will not be counted against the criteria of "continuous days of operation." If an individual train has a production capacity below 75 percent of its design production capacity for more than 24 hours, the IPT will be considered a failure.

H. If during the IPT, the system fails or shuts down, the IPT shall then be rerun, as described above, and additional testing, labor, materials, equipment, etc., associated with correcting deficiencies in the UV system, including the repeated performance test, shall be borne by the SUPPLIER. Each repetition of the IPT shall be for a continuous period unless failure to meet performance requirements as defined in this specification has been documented and modifications have been accomplished.

I. During the IPT, the City shall have the option of collecting samples for independent analyses to confirm measurements and analyses conducted by the SUPPLIER and the Contractor. The Engineer and the City shall have the option of witnessing all testing performed by the SUPPLIER and the Contractor. The SUPPLIER shall notify the Engineer a minimum of 2 weeks in advance of testing.

J. If the UV Disinfection Equipment System fails to successfully complete the IPT, the SUPPLIER shall have the option of repeating the test two more times, with all costs borne by the SUPPLIER.

3.07 ELECTRICAL ACCEPTANCE TESTS

A. Electrical Acceptance Tests: Verification of warranted power consumption shall be documented by electrical acceptance testing performed by the SUPPLIER with the oversight of the Engineer. This acceptance testing is separate and independent from the operational acceptance test described above, but may be conducted concurrently:

1. Electrical acceptance test shall consist of consecutive 8-hour measurement of kW usage and power factor on the UV bank(s) by the SUPPLIER. Test Protocol: Banks or Modules of the UV system shall be operated with all lamps in operation at 100 percent power. During this acceptance test, the power consumption, power factor and harmonic values at maximum power shall be measured at the PCC and continuously recorded using a power meter/analyzer (provided by the SUPPLIER for the duration of electrical testing).
2. The meters each shall provide accuracy of ± 0.25%, shall operate at frequencies between 47 to 63 Hz, and shall be furnished with a statement from the meter SUPPLIER attesting to its accuracy. The meters shall be connected to the PCC at a location acceptable to the City. In the event that SUPPLIER disputes result of the electrical acceptance testing SUPPLIER shall bear the entire cost of retesting by a third party mutually acceptable to City and SUPPLIER.
3. If maximum power consumption exceeds 35.0 kW for each UV train (two UV banks) with all UV lamps ON at 100 % power, the SUPPLIER shall make any and all modifications necessary to cause the system to meet the requirements, all without any additional cost to the City and meet the requirements of the Power Consumption Guarantee.
4. If the power factor is less than that as specified herein, the SUPPLIER shall provide any modifications necessary to adjust the power factor to meet the required power factor.
5. The installed UV equipment shall comply with the maximum harmonic distortion levels in IEEE 519-2014 Tables 1, and 2 as measured at the PCC. If the harmonic values exceed those recommended in the IEEE 519-2014 Standards for a general system classification, the SUPPLIER shall provide all modifications necessary to cause the system to meet the requirements without any additional cost to the City. The short-circuit current (Isc) at the PCC is 50,000 amps at 480 volts.

3.08 TRAINING OF CITY'S PERSONNEL AND SUPPORT SERVICES

A. General Requirements:

1. Provide operations and maintenance training for items of mechanical, electrical and instrumentation equipment. Utilize SUPPLIER's representatives to conduct training sessions.
2. Coordinate training sessions to prevent overlapping sessions.

3. Provide Draft Operation and Maintenance Manual for specific pieces of equipment or systems prior to training session for that piece of equipment or system.
4. Satisfactorily complete Alarm and Hydraulic Testing before beginning operator training.
5. Following City's acceptance of Certificate of Proper Installation, the SUPPLIER shall perform a comprehensive training of City's personnel at the site or a classroom designated by the Engineer.
6. The training provided by the SUPPLIER's representative shall consist of both classroom and field training.
7. The SUPPLIER shall give the City a minimum of 30 days' notice prior to initiation of training. The SUPPLIER shall provide the City a copy of the printed training material for review when notice is given.
8. The SUPPLIER shall designate and provide one or more persons to be responsible for coordinating and expediting training duties. The person or persons so designated shall be present at all training coordination meetings with the City.
9. The SUPPLIER's coordinator shall coordinate the training periods with City personnel and shall submit a training schedule for each component of the UV Disinfection Equipment System for which training is to be provided. Such training schedule shall be submitted not less than 30 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

B. Specific Requirements per UV System:

1. In addition to the time necessary to complete the requirements established elsewhere within these Specifications, the SUPPLIER's representative shall also provide onsite services at times designated by the City, for the minimum person-days listed below, travel time excluded.
2. Installation Supervision and Inspection: Minimum 7 person-days to handle various requests by the City, including during the unloading of UV disinfection equipment system (assume one trip) and for providing installation assistance for the UV Disinfection Equipment System (assume one trip).
3. Start-Up and Field-Testing: Minimum 10 person-days to handle various requests by the City, for assistance during startup activities (assume two trips).
4. Operator Training: Training shall consist of a minimum of total of 16 hours, for multiple classes, of hands-on lectures on the UV Disinfection Equipment System operation and the maintenance requirements, including lamp chemical cleaning and replacement and repair processes for lamps, ballasts, wipers, sleeves and ancillary equipment. Training shall take place before the Initial Performance Test. The field training shall cover all shifts.
5. Maintenance Service – Service Scheduling:

    a. By City request any time during warranty period as specified on the Warranty Form.

6. SUPPLIER shall return for 2 additional days 1 year after final acceptance to review UV Disinfection System performance, operations, and maintenance.

7. Factory representatives of the SUPPLIER who have complete knowledge of the proper operation and maintenance of the equipment, shall be provided to instruct representatives of City on the proper start-up, operation, and maintenance.

C. The SUPPLIER shall include in his final proposal a price for the time and expenses listed above.

D. The SUPPLIER's representative shall be a qualified individual who has previously provided onsite services for the installation, testing, and startup of the SUPPLIER's identical system at a minimum of five wastewater treatment plant of similar size.

E. Telephone: Include the following in lump sum price:

1. Provide telephone support by means of a toll-free phone number for a minimum period of 3 years following installation and startup.
2. Provide a list of three or more names of individuals qualified to support operation and provide cell phone numbers for these individuals. At least one of the listed individuals shall be available at all times including nights, weekends, and holidays in the event of an emergency.

F. Service Scheduling:

1. By City, on request any time during warranty period as specified.
2. Factory representatives of the SUPPLIER who have complete knowledge of the proper operation and maintenance of the equipment, shall be provided to instruct City on the proper start-up, operation, and maintenance.

3.09 ELECTRICAL CONNECTIONS AND CONTROLS

A. Wiring and conduits for electrical power, controls, and instrumentation shall be provided by the CONTRACTOR.

END OF SECTION

INDEX TO

SECTION 44 45 16 – FINE BUBBLE DIFFUSERS

SECTION 44 45 16

FINE BUBBLE DIFFUSERS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Division 1 specification Sections, apply to this Section.

B. Additional requirements related to work specified in this Section include, but are not limited to, the following:

Section	Description
45 50 00	Membrane Bioreactor

1.2 SCOPE OF WORK

A. This section includes the design, manufacture, installation and start-up of a flexible membrane, fine pore aeration system including in-basin aeration components as shown on the Drawings and as specified herein.

B. The aeration system manufacturer shall provide single source responsibility for the complete aeration system including in-basin piping, diffuser assemblies and support components.

1.3 DEFINITIONS

A. Tank: Vertical walled reactor within which aeration occurs.

B. Diffuser Unit: Fabricated unit including diffuser support frame and flexible membrane which releases air to the water.

C. Diffuser Assembly: Fabricated assembly including diffuser units and assembly mounting components.

D. Air Drop Pipe: Vertical piping section from out-of-basin header stub to in-basin aeration system.

E. Air Manifold Piping: Air distribution piping from drop pipe to air distribution headers.

F. Air Header Distribution Piping: Air distribution piping from air manifold and diffuser assemblies.

G. Air Header Piping: Out-of-basin air distribution piping from the blower building to the header stubs.

H. Blower Manifold Piping: Air distribution piping between the blower discharge and air header piping.

I. Aeration Grid: Associated piping and diffuser components connected to a single drop pipe.

J. Standard Cubic Feet per Minute (scfm): Air at 68°F, 14.7 psia and 36% relative humidity.

K. Maximum Pressure: Pressure in blower manifold piping at the specified airflow rate.

L. Oxygen Transfer Efficiency: Percent of oxygen in the air stream that is dissolved to the wastewater under specified conditions of temperature, barometric pressure, airflow rate, and dissolved oxygen concentration.

M. Standard Oxygen Transfer Efficiency: Percent of oxygen in the air stream that is dissolved to clean water under conditions of 68°F, 14.7 psia, and zero dissolved oxygen.

N. Air Distribution Uniformity: Variation in air distribution between diffuser assemblies.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design in-basin air piping and diffusers to diffuse air throughout the aeration tank(s) in accordance with the specifications.

2. Design each diffuser assembly to provide uniform air release over the specified airflow range.

3. Design the aeration system to provide the specified oxygen transfer at the specified conditions.

1.5 SUBMITTALS

A. General:

1. A detailed engineering submittal package shall be provided in sufficient detail and scope to confirm compliance with the requirements of this section. Submittals shall be completed for all required components. Partial submittals will not be accepted.

B. Shop Drawings:

1. Detailed layout drawings for in-basin aeration components. Layout drawings shall include:

a. Layout and configuration of aeration system.

b. Detail drawings of diffuser assemblies showing components, method of construction, and attachment mechanism to air header distribution piping.

c. Detail drawings of all piping connections including drop to manifold, manifold to header and inline connections for manifold and headers.

d. Detail drawings of pipe support components.

C. Product Data:

1. Detailed listing of materials and materials of construction.

2. Product literature.

3. A complete bill of materials.

D. System Design and Performance Data:

1. The recommended minimum, average, peak, and maximum air flow per diffuser.

2. Design AOR to SOR calculations according to EPA method for fine bubble diffuser design showing air flow rate in SCFM and SOTE at the design conditions listed in this specification for the following:

a. average AOR

b. Peak AOR

3. Design calculations according to the EPA method for fine bubble diffusers showing AOR for the proposed system at the design conditions listed in this specification for the following:

a. Minimum air flow rate per diffuser

b. Maximum air flow rate per diffuser

4. A curve showing the oxygen transfer efficiency of the proposed system for air flux rates between the minimum and maximum air flow rates per diffuser at design conditions.

5. Include complete air headloss calculations for the aeration equipment from the top of the dropleg to the farthest diffuser bubble release point.

6. Design calculations showing uniform air distribution (+10% maximum variation) between any two diffuser units.

7. Design calculations for piping and support components.

8. Product Experience:

a. The supplier shall have experience in the design, manufacture, supply and commissioning of fine pore, flexible membrane aeration equipment identical to the type specified for this project.

b. The equipment submitted shall be of proven design and shall be referenced by at least three installations of similar size, having been in successful operation for a period of not less than four (4) years prior to bid date.

9. Guarantee:

a. All equipment and workmanship furnished under this contract shall be guaranteed to be free of defects in materials and workmanship for a period of twelve (12) months from the date of system start-up or eighteen (18) months from the date of shipment, whichever occurs first. Any such defects, which occur within the stipulated guaranty period, shall be repaired, replaced or made good at no cost to the Owner.

E. Installation Instructions:

1. Installation requirements and guidelines for all proposed equipment shall be provided.

2. Information on the aeration system shall include but not be limited to:

a. Diffuser unit assembly.

b. Diffuser assembly attachment.

c. Piping components and assembly.

d. Piping support components.

e. Any other information required to properly install the system provided.

F. Operation and Maintenance Data:

1. Operations and maintenance data for all proposed equipment shall be provided.

2. A testing plan designed to ensure consistently good quality and uniformity of the aerator assemblies.

3. Information on the aeration system shall include but not be limited to:

a. Air flow balancing.

b. Diffuser assembly maintenance and membrane replacement.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. General

1. The following manufacturers are acceptable provided they meet the requirements of this specification.

a. Aerostrip

b. Sanitaire

c. Acceptable Equivalent.

2.2 MATERIALS

A. Welded Stainless Steel Components:

1. Sheets and plates of Type 304 stainless steel with 2D finish conforming to AISI 304 and ASTM A240.

2. Limit carbon content to 0.30% maximum.

B. Non-welded Stainless-Steel Components:

1. Sheets and plates of Type 304 stainless steel conforming to AISI 304 and ASTM A240.

C. Fasteners and Anchorage Components:

1. 304 series stainless steel.

D. PVC Pipe and Fittings (Schedule 40 and 80):

1. Base material shall be ASTM D-1784.

2. Pipe shall be manufactured in accordance with ASTM D-1785 and ASTM D-2665.

2.3 AERATION EQUIPMENT

A. System Performance:

1. The aeration-mixing system(s) shall be designed to meet the following conditions:

2.

System Name	**Pre-Aeration diffuser grid**
Average AOR	TBD based on MBR zone contribution to AOR. Total

	12,000 lbs 02/day required for both pre air and MBR zone contributions.
Peak AOR	TBD based on MBR zone contribution to AOR. Total 18,000 lbs 02/day required for both pre air and MBR zone contributions.
Peak Dissolved Oxygen Concentration	1 mg/L
Average Dissolved Oxygen Concentration	2 mg/L
Minimum SOTE	2% per foot submergence
Alpha	.65
Beta	.95
Wastewater Temperature	20
Elevation	25 feet
Number of Basins	As shown on the plans
Basin Length	As shown on the plans
Basin Width	As shown on the plans
Side Water Depth	As shown on the plans

B. Flexible Membrane, Fine Pore Diffusers:

a. The diffuser unit shall be fully capable of operating under continuous or intermittent conditions.

b. Membrane shall be elastic and allow openings to close when the air supply is interrupted.

1. Diffuser assemblies shall be completely factory assembled.

a. Field solvent welding or assembly of diffuser unit is not acceptable.

2. Diffuser assemblies shall be shipped to the jobsite assembled and properly crated and protected for shipment and handling.

C. Aeration System Piping:

1. Out-of-basin air piping including blower manifold, air header, and header stubs are required and are to be supplied by others.

a. Fine bubble diffuser system and system maintenance shall be compatible with out of basin unlined ductile iron, galvanized steel, or stainless steel.

b. Others shall provide an isolating/balancing valve for control and distribution of air to the aeration grid and to allow isolating of the grid for inspection and maintenance on the header stub.

c. Isolation/balancing valve shall be positioned for accessibility from the top of the tank.

2. Drop pipes from top of basin headers to floor level diffuser grid shall be provided by installing contractor.

3. All submerged manifolds and header components shall be Schedule 40 PVC minimum.

    a. Use of PVC piping shall only be employed when diffuser mounting system reinforces pipe wall at each mounting location.

4. Pipe supports shall be all stainless-steel construction.

    a. Supports shall accommodate longitudinal movement in the piping components due to the thermal expansion and contraction over a temperature range of 100°F.

    b. Supports shall restrain the axial and rotational movement of the pipe while providing for unrestrained longitudinal movement.

    c. Supports shall allow leveling of the air piping with 2-inch minimum vertical adjustment at each support.

    d. Each pipe support shall be connected to basin floor by at least 2 anchor bolts.

    e. The integrated pipe support assembly shall be designed to withstand the associated uplift force of the piping and diffuser assemblies with a minimum design factor of safety equal to ten (10).

PART 3 – EXECUTION

3.1 INSTALLATION

A. Contractor shall furnish, inspect, store, and install aeration system in accordance with manufacturer's written instructions and approved submittals.

B. Diffuser assemblies on a common grid shall be installed within an elevation tolerance of ±1/4 inches.

C. Contractor shall provide all valves, air header piping, wall sleeves with seals, wall pipes, and concrete pedestals as necessary to complete the system as shown on the plans.

D. Air piping including blower manifold, header, and in-basin piping must be clean prior to delivering air up the diffusers.

E. Contractor shall be responsible for cleanliness of piping and may be required to manually clean pipe, or air or water flush piping as required.

3.2 START-UP

A. After installation is completed, the Contractor shall perform the following field tests in the presence of the Engineer and the Owner.

1. Fill the reactor to the bottom of the diffuser assemblies.

2. Adjust the pipe supports and diffuser assemblies such that all diffuser units are installed within ±1/2 inches of the design diffuser elevation.

3. Fill the reactor to a level of 2 feet above the top of the diffusers.

4. Release air to the system and inspect the system for air leaks at all piping or diffuser connections.

5. Check all membrane for cuts or tears that may have occurred during the installation.

6. Adjust any piping or diffusers that show leaks or disproportionate amount of airflow.

7. Operate the blowers at the design air rate and observe air release and air distribution patterns.

8. All water, air, power and labor associated with testing and adjustment of diffuser assemblies are to be supplied by Contractor.

END OF SECTION

INDEX TO

SECTION 44 45 16.1 – EFFLUENT OXGENATION SYSTEM

SECTION 44 45 16.1

EFLLUENT OXYGENATION SYSTEM

PART 1 – GENERAL

1.01 RELATED SECTIONS

A. Section 26 05 00 – General Equipment Requirements
B. Section 40 27 05 – Piping
C. Section 40 29 19 – Plug Valves
D. Section 40 91 00 – Instrumentation and Controls

1.02 REFERENCE STANDARDS

A. The following is a list of standards which may be referenced in this section:

1. Occupational Safety and Health Administration (OSHA)
2. National Fire Protection Association (NFPA) 53
3. Compressed Gas Association (CGA) G-4.1
4. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (BPVC) Section VIII, Div. 1
5. ASME B16.1/B16.5 Pipe Flanges and Flanged Fittings.

1.03 SYSTEM DESCRIPTION

A. The Effluent Oxygenation System is designed to elevate dissolved oxygen (D.O.) levels at the City's WRF to assist in meeting permit requirements.
B. The Effluent Oxygenation System includes the following components, which are each supplied by individual manufacturers.

System Component	Qty
Oxygen Injection System	1
Sidestream Pumps	2
Air Compressor System	2
Oxygen Generator System	1
200 Gal. Oxygen Storage Tank	3
Oxygen Compressor	1

C. The Contractor is responsible for providing each component of the Effluent Oxygenation System, as well as complete system integration, including all installation and interconnecting piping and wiring.

PART 2 – PRODUCTS - OXYGEN INJECTION SYSTEM

2.01 OXYGEN INJECTION SYSTEM OPERATION CONDITIONS

A. One Oxygen Injection System shall be provided to operate under the following operating conditions:

Process Parameter	Value
Plant Effluent Flow Method	Pumped
Location of Oxygen Addition	Post Effluent Pump Station
Site Elevation Above Sea Level (ft)	~100
Max Temperature of Effluent (°C)	25
Oxygen Transfer Efficiency (OTE)	90%
Total Daily Oxygen Addition Required (lbs O_2/day)	534 @ 20 ft in Cone

B. One complete Oxygen Injection System includes the following components: include:
1. Oxygen Injection Speece Cone for the rapid dissolution of oxygen gas
2. Oxygen Injection System Controls, consisting of 2 separate panels:

    a) PLC based Process Control Panel with Pump Starter.
    b) Oxygen Flow Control Panel.

2.02 OXYGEN INJECTION SPEECE CONE

A. Oxygen Injection Speece Cone Dimensions and Parameters:

1. Model Number: ECO2-4-6-PC
2. Cone Diameter: 4 feet.
3. Cone Nominal Height: 12 feet.
4. Total head loss shall not exceed 25 feet through the Oxygen Injection System at design conditions.
5. Side Stream Flow Rate: 1,100 gpm.
6. Side Stream Pump Duty Head: 35 feet, plus friction losses.

B. The Oxygen Injection Speece cone shall be constructed of Type 304 stainless steel and fabricated to ASME standards for 100 psig pressure rated vessels.

C. Features:

1. Self-cleaning bottom discharge design.
2. Sight glasses.
3. Manway.
4. 6-inch ANSI 150-pound flanged inlet and discharge ports.
5. 1-inch female NPT threaded oxygen port.
6. System discharge instrumentation ports.
7. Bead blast finish.
8. Free standing vessel with lower mounting flange for anchoring.

2.03 OXYGEN INJECTION SYSTEM CONTROLS

A. Provide One Process Control Panel: PLC driven automatic system control with sensing features. The system shall be designed for automatic flow control with full manual backup control of oxygen flow and side stream pump control. The oxygen feed rate shall be continuously adjusted to the actual process water flow rate. The control panel shall be rated for use on a 120-volt power supply and shall be housed in a NEMA Type 4X stainless steel, 316 enclosures. The control panel shall contain an Allen-Bradley Programmable Logic Control (PLC), operator interface screen and have the capability to monitor system parameters for alarm indication and data logging and trending.

1. Instrumentation included with the system and controlled/monitored by the Process Control Panel:
    a. Oxygen mass flow controller.
    b. One (1) solenoid valve.
    c. One (1) actuated ball valve.
    d. Side stream flow meter.
    e. Side stream pressure sensor.
    f. Side stream temperature sensor.

2. PLC and I/O:

    a. Allen-Bradley MicroLogix Processor.
    b. Ethernet switch.
    c. MicroLogix fixed racks, power supplies, expansion analog and digital I/O.
    d. Trend recording: The PLC shall record the following data as a minimum:

        1) Oxygen addition, current day's total.
        2) Oxygen addition, previous day's total.
        3) Plant effluent flow.
        4) Side stream flow.
        5) Side stream pressure.
        6) Side stream temperature.

3. Operator Interface:

   a. Panel Door-mounted HMI:

      1) Trending and logging.
      2) Ethernet communication capable (for remote connection).

4. Main Control Enclosure:

   a. Preassembled and wired, NEMA 4X 316 stainless steel construction.
   b. System Hand-Off-Auto switch.
   c. Interposing I/O relays as necessary.
   d. Disconnects and fusing for AC power distribution.
   e. DC power supply and fusing for DC power distribution.
   f. All necessary wireways, wiring, labels, and miscellaneous hardware for a complete control panel.

B. Provide one Oxygen Flow Control Panel: **NEMA 4X, 316 Stainless steel** panel complete with oxygen mass flow controller, rotameter, solenoid valve, check valves, isolation valves and stainless-steel tubing and fittings as required. Panel will be powered, monitored and controlled by the Process Control Panel.

C. Additional Components: The following additional components will be provided for mounting on the Speece Cone for redundant control and system isolation of the oxygen delivery piping:

   1. Isolation valve
   2. Check valve.
   3. Actuated ball valve.

D. External Inputs to Process Control Panel: (provided by the G.C)

   1. Plant effluent flow rate.
   2. Side stream pump signal(s).
   3. System enable/permission to run.
   4. Effluent D.O sensor signal

E. Description of Operation:

   1. The Oxygen Injection System shall operate by redirecting a side stream of plant effluent and pumping it through the Speece Cone. Gaseous oxygen is fed into the Speece Cone by the Oxygen Control Panel as controlled by the Process Control Panel. The Speece Cone shall provide a large oxygen/water interface as generated by an intense bubble swarm

to achieve rapid oxygen dissolution such that the gaseous oxygen is completely dissolved before being blended back into the main effluent flow. The Oxygen Injection System shall not have a pure oxygen headspace inside of the vessel. The system shall contain no internal nozzles, mixers or inner baffles that are prone to clogging, and all openings shall be a minimum of 3 inches to avoid scaling and clogging. The Oxygen Injection System shall not be pressurized above the operating pressure of 20 ft of head.

2. The Process Control Panel PLC shall monitor the plant effluent flow rate, side stream water flow rate, and water temperature and system pressure. Based on this data, the PLC shall calculate the amount of oxygen required to meet the oxygen demand of the plant effluent. The PLC shall be capable of adjusting the oxygen feed rate into the Speece Cone by means of the mass flow controller to match the calculated oxygen demand.
3. The Oxygen Injection System shall be capable of automatically adding variable amounts of oxygen as required by varying plant effluent flow rates.
4. The PLC shall also monitor the side stream pump operation, side stream water flow rate, oxygen flow rate, and water temperature and system pressure. These parameters shall be checked against design inputs to ensure optimal system performance and provide for system shutdown and/or alarm notification if the operation is out of tolerance.

2.04 OXYGEN INJECTION SYSTEM SUPPLIER

A. Supplier Qualifications

1. The Oxygen Injection System Supplier shall have a minimum of 5 years of experience in similar installations with a minimum of 10 permanently installed and operating systems adding a similar amount of oxygen to what are required per these specifications. Five of the 10 systems need to be in operation greater than 3 years.
2. The System Supplier shall submit performance data from a minimum of 10 permanently installed and operational systems that prove a minimum oxygen transfer efficiency of greater than 90% under actual operating conditions. Data from factory tests with clean water or data from temporary pilot tests is not acceptable.
3. To achieve the high oxygen transfer efficiency, the system shall provide a large oxygen/water interface generated by an intense bubble swarm to achieve oxygen dissolution such that the gaseous oxygen is completely dissolved into the wastewater before being blended back into the main flow.
4. System operating pressure shall not exceed 20 feet of head.

5. Systems with a pressurized pure oxygen headspace shall not be considered.
6. The Oxygen Injection System should run continuously with a minimum amount of maintenance to guarantee reliable D.O. control. Therefore, the system shall contain no internal nozzles, mixers or inner baffles that are prone to clogging, and all openings shall be a minimum of 3 inches to avoid scaling and clogging.
7. The System Supplier shall be ECO Oxygen Technologies, LLC of Indianapolis, IN.

B. Unit Responsibility and Scope of Supply:

1. The Contractor shall be responsible for coordinating with Oxygen Injection System manufacturer for Contractor's Scope of Supply.
2. One complete Oxygen Injection System includes the following components:
   a) Oxygen Injection Speece Cone.
   b) PLC based Process Control Panel with Pump Starter.
   c) Oxygen Flow Control Panel.
3. The Contractor shall be responsible to provide and install, but not limited to, the following:
   a. Interconnecting water piping including valves and accessories.
   b. Oxygen feed piping to the System, and accessories.
   c. Installation and assembly of all equipment and instrumentation components for a complete system including labor.
   d. Site preparation
   e. Utility requirements, including main electrical service and field wiring.

2.05 SUBMITTALS

A. Action Submittals:

1. Detailed mechanical and electrical drawings showing equipment dimensions, system fabrication, arrangement, assembly, including locations and type of connections and weights of major equipment and components.
2. Power and control wiring diagrams, including terminals and numbers.
3. Factory finish system.
4. External utility requirements such as air, water, power, drains, etc., for each component.
5. Functional description of internal and external instrumentation and controls to be supplied including list of parameters monitored, controlled, or alarmed.
6. Control panel elevation drawings showing panel face layout, construction, and placement of operator interface devices and other elements.

7. Power and control wiring diagrams, including terminals and numbers and bill of materials
8. Complete set of engineered drawings for system I/O and Process control.
9. Installation Manual.
10. Installation history and experience –The manufacturer shall provide a list of names and dates of installations for verification by the Engineer or City's Representative.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance.
2. Warranty Certificate
3. Operation and Maintenance Manuals (3 hard copies, 1 electronic copy).
4. Manufacturer's Certificate of Proper Installation.
5. Equipment Testing and Field Startup Report.

2.06 WARRANTY

A. The manufacturer shall guarantee that the Oxygen Injection System will perform in accordance with the specifications when operated within the specified design conditions.

B. The manufacturer shall guarantee all materials and equipment to be free from all defects due to faulty materials or workmanship for a period of one (1) year from the date of startup and shall be limited to the repair or replacement of the Oxygen Injection system.

2.07 PERFORMANCE GUARANTEE

A. Oxygen Injection System Supplier shall guarantee that the System shall provide a minimum oxygen transfer efficiency of 90% or greater.

B. One-time performance testing as conducted during startup shall be means of proving performance criteria is met.

PART 3 – PRODUCTS – SIDE STREAM PUMPS

3.01 SIDE STREAM PUMPS

A. Quantity (2) Dry-Pit Pumps Flygt shall be provided, to act in duty/standby configuration for pumping a sidestream from the effluent force main, through the Oxygen Injection System, and return to the effluent force main.

B. Pump:

a. Furnish and install Two (2) dry pit non-clog wastewater pump(s). Each pump shall be equipped with a 20 HP submersible electric motor, connected for operation on 460 volts, 3 phase, 60 hertz, 52A wire service, with T-stand kit, Mount socket, and 8" ANSI Inlet Elbow Assembly.

C. Performance Requirements:

a. Capacity: 1,100 gpm.
b. Total Dynamic Head: 40 ft of head.
c. Minimum Rated Pump Hydraulic Efficiency at Rated Capacity: 75 percent
d. Constant speed.

D. Pump Configuration:

1. Pump shall be capable of operating in a continuous non-submerged condition in vertical (NT) position in a dry pit installation, 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.

E. Pump Construction:

1. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts or bolts shall be of stainless-steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
2. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
3. Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

F. Cooling System:

1. Each unit shall be provided with an integral motor cooling system. A stainless-steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the

pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

G. Cable Entry Seal:

1. The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered equal.

H. Motor:

1. 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.
2. 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 trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%.
3. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31.
4. 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. The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable.
5. The motor shall be designed for continuous duty while handling pumped media of up to 104°F.
6. The motor shall be capable of no less than 30 evenly spaced starts per hour.
7. The rotor bars and short circuit rings shall be made of aluminum.
8. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches

shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.

9. The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.
10. The motor service factor (combined effect of voltage, frequency and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of +/- 10%.
11. The motor shall be designed for continuous operation in up to a 40°C ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.
12. Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

I. Bearings:

1. The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease.
2. The upper motor bearing shall be a two-row angular contact ball bearing.
3. The lower bearing shall be a two-row angular contact ball bearing to handle the thrust and radial forces.
4. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

J. Mechanical Seals:

1. Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two seal sets, each having an independent spring.
2. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide ring.
3. The upper secondary seal located between the seal chamber and the seal inspection chamber shall be a leakage-free seal.
4. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed

upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber.

5. All seal rings shall be individual solid sintered rings.
6. Each seal interface shall be held in place by its own spring system.
7. The seals shall not depend upon direction of rotation for sealing.
8. Mounting of the lower seal on the impeller hub is not acceptable.
9. 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 are not acceptable.
10. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.
11. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.
12. The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.
13. A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.

K. Pump Shaft

1. The pump and motor shaft shall be a single piece unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100-T. Shaft sleeves will not be acceptable.

L. Impeller

1. The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The screw-shaped leading edges of the gray iron impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the

impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

M. Volute/Suction Cover

1. The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

N. Protection

1. Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.
2. The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.

O. Manufacturer and Product: Flygt; N-Series.

PART 4 – PRODUCTS – AIR COMPRESSOR SYSTEM

4.01 AIR COMPRESSOR SYSTEM GENERAL

A. Quantity (2) Rotary Screw Air Compressors Systems shall be provided, to act in duty/standby configuration.

B. Each Compressor must meet the inlet air requirements for the Oxygen Generation System as listed below:

1. Feed Air Requirements: 68 SCFM (average flow) at 100 PSIG incoming pressure
2. Air Quality Requirements (per ISO 8573.1 CLASS 1.4.1 MINIMUM):
3. Zero Dirt Particles larger than 1-5 Micron
4. Oil Concentration (including vapor) at or below 0.01 (</= 3ppm)
5. Water Pressure Dewpoint at or below +38 deg F (940ppm at 100 PSIG)

C. Air compressor shall be a single stage, fluid-injected, air-cooled rotary screw compressor completely pre-piped and with pre-wired control system panel. Compressor shall be Kaeser Compressors, Inc., model SK20T or pre-approved equivalent.

D. Compressor shall be manufactured under strict ISO 9001:2008 quality control standards.

E. Compressor shall be tested as a completely assembled, piped, and wired unit.

F. Capacity shall be 88 ACFM (per CAGI) free air delivery at a discharge pressure of 125 psig. Compressor shall be capable of continuous full flow operation 24 hr./day at rated capacity and pressure.

G. Motor voltage shall be 460V, 3 phase, 60 Hz. With **20 HP** motor. Control system voltage shall be 115 V, 1 phase, 60 Hz.

H. Standard compressor package shall be suitable for use in a 40°F to 115°F ambient temperature range.

I. Dual Compressor System shall be provided with integral refrigerated dryer with oil/moisture separator and automatic condensate drain.

J. Drive Motor shall have TEFC enclosure.

K. Control Cabinet

1. Control cabinet shall be designed to meet outdoor standards.
2. Electrical components shall be UL and/or CSA approved and labeled as required.
3. Electrical schematic diagram shall be included in the service manual for ease of reference.
4. Cabinet backplate shall be galvanized for improved grounding.
5. Starter(s) shall be integrally mounted and wired in the package and located in the control enclosure.
6. Starter(s) shall either be magnetic, wye-delta, reduced voltage starter(s), to ensure low starting current and reduce thrust-bearing loads; or, with variable frequency drive.

M. Compressor Instrument Panel

1. Instrument panel shall consist of a Sigma Control 2™ system, or an approved equal. Control system shall be designed for ambient temperatures ranging from –4°F to +140°F.

2. The controller shall have embedded controller technology and sophisticated operating system. The unit shall include a stabilized 24V DC power supply and remote start/stop programmable timers. A buffer battery with a lifetime of ten years shall be included for protection of system memory and internal clock. The unit shall be EMI (electromagnetic interference) protected to ensure proper functioning of the controller in industrial conditions. The unit shall include additional digital and analog inputs and outputs for monitoring of standard and optional sensors.
3. Standard communications include: RFID for user access and security, Ethernet for remote monitoring with included Web Server, and an SD card reader slot to enable long term data logging and saving of system parameters.
4. A user interface shall be integral to the unit and shall include ergonomic controls with LED indication of important functions, and a background illuminated, plain text and graphical display capable of displaying information in many languages.
5. The controller shall monitor critical compressor and control functions and shut the compressor down in the event of motor overload, high airend temperature, incorrect rotation, or loss of drive.

N. Compressor Control

1. Sigma Control 2™: Compressor shall have the option of Quadro, Vario, Dual, Continuous, and Dynamic control as standard. Switchable modulation control is an acceptable option. Compressor shall start and automatically load if system demands it. Compressor shall have adjustable time delay to shut down the compressor after running unloaded for a pre-determined period of time to avoid excessive motor starting.
2. Compressor shall cut in and out at a specific psig.

O. Compressor Enclosure

1. Compressor shall have steel frame assembly and be completely enclosed, including bottom. All models shall include hinged doors and/or removable access panels for easy access to the compressor for maintenance. All models shall incorporate a safety interlock switch on front access panel for protection of operators and maintenance personnel.
2. Enclosure shall be suitable for installation outdoors.
3. Enclosure shall be heavily sound insulated, and compressor shall have a maximum full load sound level of 68 dB(A) at 3 feet in accordance with ISO 2151 and ISO 9614-2. All sound dampening material shall be oil repelling and cleanable.
4. Additional vibration proofing shall be provided for the airend, drive motor, and separator tank to reduce stress on piping and electrical connections.
5. Compressor frame shall be isolated from the floor by rubber vibration pads. No special foundation shall be required.
6. All access panels/doors shall have slotted key locks or handles. A door key shall be provided.
7. Ambient cooling air shall enter enclosure after passing through a 40-micron filter mat.

8. Compressor shall be fitted with an air inlet filter rated at 1 micron.
9. Cabinet panels shall have a "powder coat" type paint finish, which shall be durable and scratch-resistant.
10. All access panels/doors shall be gasketed to minimize dust or dirt entering the compressor enclosure.
11. All major air and oil pipes shall be made of steel and feature flexible connections with o-ring seals to reduce the likelihood of cracks and leaks.

P. Testing & Inspection

1. Parts must be inspected as part of a strict ISO 9001:2008 quality control program.
2. Each compressor shall be run and tested for leaks, pressure, temperature, rotation, and full load amp draw.

Q. Maintenance and Spare Parts

One (1) year of standard maintenance parts shall be provided.

R. Standard Limited Warranty

Compressor package shall be warranted free of defects in material and workmanship for a minimum period of 18 months from date of shipment or 12 months from date of start-up, whichever occurs first. Compressor assembly, drive motor, magnetic motor starter(s), Sigma Control 2 shall be warranted to be free of defects in material and workmanship for a minimum period of 30 months from date of shipment or 24 months from date of start-up, whichever occurs first. There shall be no restrictions based on the purchase of special lubricants or maintenance kits.

PART 5 – PRODUCTS - OXYGEN GENERATION SYSTEM

5.01 OXYGEN GENERATION SYSTEM

A. One Oxygen Generation System shall be provided to supply high purity oxygen gas to the Oxygen Injection System where it will be dissolved into the plant's effluent, according to the following specifications:

1. The Oxygen Generator shall produce a minimum of 375 Standard Cubic Feet per Hour (SCFH) of Oxygen Gas from a source of clean, dry, compressed feed air
2. The Oxygen Generator System requires feed air to meet the following specifications (see section 4.01.B)
    a. Meets specification for the feed air quality us the ISO Specification 8573.1, Class 4. It states: Maximum Dust Particle size is 15µm; Maximum Oil content, including vapor, is 5 ppm; and Maximum dewpoint at 100 psig is 37°F or 940 ppm.
    b. Feed air volume is 68 SCFM on average, at capacity of at least 200 gallons

3. The Oxygen Gas produced by the Oxygen Generator shall have a concentration of 93.0% (+/- 3.0%).
4. The compressed feed air must be available from an Air Storage Tank (AST) with a storage capacity of at least 200 gallons. Tanks must be suitable for outdoor installation.
5. The Oxygen Gas produced by the Oxygen Generator shall be available from an Oxygen Storage Tank (OST) with a storage capacity of at least 200 gallons at a minimum pressure of 45 psig (3 Bar). Tanks must be suitable for outdoor installation.
6. The Oxygen Gas produced by the Oxygen Generator shall have a Maximum dewpoint of -76°F (-60°C) and typically be in the range of -100°F (-73°C).
7. The Oxygen Generator shall be painted green, which normally identifies equipment or transmission lines and hoses as containing Oxygen.
8. The Oxygen Generator shall be made in the USA.

5.02 DESIGN REQUIREMENTS

A. The Air Separation Technology used shall be Pressure Swing Adsorption (PSA) utilizing a two-bed system with both Pressure Equalization and Gas Purging to enhance system efficiency.

B. The Sieve Beds of the Oxygen Generator shall be designed, built, tested, inspected and stamped ('U' Stamp only, not 'UM'-stamped) in accordance with the American Society of Mechanical Engineers' (ASME) Boiler code, Section 8, Division 1.

C. The electrical and pneumatic controls for the Oxygen Generator shall be located inside an electrical enclosure box. An electrical enclosure box rated as **NEMA 4X, 316 S.S.** (IEC rated IP 66) shall be available which will provide a degree of protection against corrosion, windblown dust and rain and splashing or hose directed water.

D. The operation of the Oxygen Generator shall be controlled by a Programmable Logic Controller (PLC) which meets Conformite European (CE) guidelines for Noise Immunity and Radio Frequency Interference (RFI).

E. The PLC shall have at least one data communication port.

F. The wiring connections inside the enclosure box shall be made to valves, switches and power distribution terminals through DIN- rated electrical connectors. The entire system shall be rated 'Touch-Safe' and Compliant with CE Machinery Safety Regulations.

G. The DIN electrical connectors to the process control valves shall have internal lights to indicate when each valve is energized.

H. The wiring color shall conform to the International Standards Organization (ISO) Standard for Wiring Color Code (Brown-Hot, Blue-Neutral, Green/Yellow-Earth).

I. The electrical power consumption of the Oxygen Generator shall be less than 0.5 KW. The power supply for the oxygen generator shall be from a single-phase source of 115 or 230 VAC at 60 Hz.

J. The power supply for the air compressor shall be from a three-phase source of 460 VAC at 60 Hz.

K. The Oxygen Generator shall have both lifting lugs, to move it via connection to an overhead crane and forklift slots, for carriage by forklift.

5.03 INSTRUMENTATION AND CONTROLS:

A. The Oxygen Generator shall have a single, internally-lighted, three position Control Switch unless supplied with a touch screen. The three positions of the switch shall allow the operator to select the mode of operation (Off, Continuous Cycling or Automatic Operation).
B. The Oxygen Generator shall have a non-adjustable Digital Hours meter that records running hours.
C. The Oxygen Generator shall have an internal pressure switch which will turn the Generator on and off based on the Oxygen Storage Tank pressure. This switch will only be affective while the 'Automatic' mode of operation is selected on the Control Switch. The pressure switch set points shall be factory set but be adjustable for modification.
D. The Oxygen Generator shall have a dial gauge to indicate the Regulated Feed Air Pressure as feed air enters the Oxygen Generator.
E. The Oxygen Generator shall have a dial gauge to indicate the Oxygen Discharge Pressure as it departs the Oxygen Generator.
F. The PLC controlling the Oxygen Generator shall have indicating lights which indicate the point in the separation process the Generator is at while it cycles.

5.04 TESTING, CERTIFICATION, AND WARRANTY:

A. The unit shall be tested at the *OGSI* facility for a minimum of 4 hours at the rated output, monitoring Oxygen Flow Rate, Oxygen Delivery pressure and Oxygen Concentration.
B. A Certificate of Conformance to the Test Parameters shall be available to the Buyer Upon Request.
C. A Certificate of Origin indicating the unit to be 'Made in the USA' shall be available to the Buyer Upon Request.
D. The manufacturer shall provide the Buyer up to one-half day of training on the operation and maintenance of the Oxygen Generator, at no extra charge, at the Manufacturer's facility.
E. The manufacturer shall provide a Warranty on the unit, that.it is free of defects in parts or workmanship (in accordance with manufacturer's Standard Warranty policy), for a period of 12 months from date of shipment. This period will be extended to 18 months from shipment in cases where startup does not occur within the first six months from the date of shipment, but in no case shall be any longer.

PART 6 – PRODUCTS - OXYGEN GAS COMPRESSOR

6.01 OXYGEN GAS COMPRESSOR

A. One (1) Oil-Less Oxygen Gas Compressor shall be supplied to increase the pressure of the high purity oxygen up to 150 PSIG.

B. The Oxygen Compressor shall receive oxygen gas from the Oxygen Storage Tank (OST), and provide the higher-pressure oxygen gas to the Oxygen Injection System Speece Cone.

C. The Oxygen Gas Compressor shall meet the following specifications:
1. Size: 28" L x 25" W x 30"H
2. Weight: 400 lbs.
3. Inlet pressure: 3-50 PSIG
4. Discharge pressure: Up to 150 PSIG
5. Air Cooled
6. Materials of construction appropriate for use with high purity oxygen gas
7. Motor: **5 HP**
8. Direct Drive
9. Power Input: 460V/3ph/60Hz
10. Controls: High Pressure Safety Shut Down
11. Operation: Continuous
12. Filtration: Y-strainer, 100 mesh

D. The Oxygen Gas Compressor shall be model 2TX1B

E. The Oxygen Gas Compressor shall be manufactured by RIX Industries, Benicia, CA

F. The Oxygen Gas Compressor shall be warranted for a period of 12 months from the date of startup, to meet the specifications herein and to be free from defects in quality and manufacture.

PART 7 – EXECUTION

7.01 GENERAL INSTALLATION

A. Manufacturers shall provide written instructions for installation of equipment by Contractor.

B. Anchor Bolts:

a. Contractor will provide, and field install after receipt of equipment.
b. Anchor bolts are as determined by local codes and regulations and Engineer's specification.

C. Equipment Materials:

a. All components of the System shall be compatible with the conditions and chemicals to which they will be subjected to during normal operation.
b. Compounds with which the materials of construction must be compatible include, but are not limited to:
i. Hydrogen sulfide.
ii. Sulfuric acid.

D. General Instrumentation and Controls

1. Provide control panels, electrical components and wiring for a complete, functional system.
2. Provide all items not specifically specified which are required to implement the specified functions and the functions required for proper system operation.
3. Coordinate controls with existing SCADA system.
4. Alarms shall be capable of being transmitted to the owner in accordance with their requirements, specified herein under Section XXXXX.

7.02 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All materials and equipment shall be shipped, stored, handled and installed in such a manner as to not degrade quality, serviceability or appearance.

B. All exposed equipment openings shall be properly protected.

C. Appropriate measures shall be taken to prevent the entrance of moisture or water to equipment during shipment and storage onsite.

1. Control panels should be stored in an enclosed place, safe from the weather until installed.

7.03 MANUFACTURER'S SERVICES

A. Startup service shall be provided by factory-trained technicians at no charge to ensure equipment is running properly and adjusted to factory specifications. Maintenance instructions shall be discussed with customer to ensure they understand routine maintenance procedures. The maintenance training shall be conducted at the time of equipment startup.

7.04 FIELD TESTING

A. Prior to acceptance by Owner, an operational test of the Oxygen Injection System shall be conducted to determine if the installed equipment meets the purpose and intent of the Specifications. Tests shall demonstrate that all equipment is electrically, mechanically, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

B. All equipment shall be tested to check for proper operation, proper alignment, faulty equipment, and for excessive vibration.

C. Any and all alterations, modifications, additions and/or work necessary to rectify defects or nonconformance with the Section of the Specifications shall be in such a manner as to provide for the satisfactory operation of the system, all at no additional cost to the Owner.

D. All labor, instruments, equipment, apparatus, fuel, temporary piping and valving, water and electrical power required for testing shall be provided by the Contractor at no additional cost to the Owner.

END OF SECTION

INDEX TO

SECTION 45 50 00

MEMBRANE BIOREACTOR (MBR) SYSTEM

SECTION 45 50 00

MEMBRANE BIOREACTOR SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

The specification sections listed below are an integral part of this equipment specification, and the Contractor shall be responsible for providing these sections to the equipment suppliers.

Section	Description
40 91 00	Process Instrumentation
43 21 39	Submersible Pumps
43 21 21	Self–Priming Pumps
40 92 43	Actuated Valves
40 95 13	MBR Control Panel
40 95 20	MBR SCADA Hardware and Software
44 42 19	Positive Displacement Blowers
44 42 46	Submersible Mixers
44 45 16	Fine Bubble Membrane Diffusers

1.02 DEFINITIONS

A. MBR/MBT System Supplier (called the MBR Supplier from here on in this document): The company responsible for supplying the membranes to be used in this project and for providing all equipment and services as described herein and for providing warranty support.

B. Contractor: The company responsible for construction and installation of the MBR System, including, but not limited to, site preparation, tank and basin construction, and mechanical and electrical installation.

C. Engineer: The Engineer is the prime professional with respect to the project.

D. MBR System: A collective term for all process and membrane zones that make a complete biological treatment system.

E. Process Train: A stand–alone combination of Process Zones designed and operated to achieve specific treatment objectives.

F. Process Zone: An area in a Process Train designed and operated to meet a specific biological treatment objective.

G. Membrane Zone: Any Membrane Tank or MBR containing membranes.

H. Membrane Tank: A tank or basin containing one or more large membrane sub–units that are operated as one unit. A Membrane Tank has an HRT at Average Design Flow (ADF) of less than 1.0 hr.

I. MBR: A tank or basin containing one or more large membrane sub–units that are operated as one unit. An MBR has an HRT at Average Design Flow (ADF) of more than 1.0 hr.

J. Membrane Bank: A grouping of large membrane subunits which share a common permeate header, a common air supply header, and that are taken off–line as an entity for any type of Clean–In–Place (CIP) procedure.

K. Submerged Membrane Unit (SMU): An assembly consisting of one or more SMU Subunits ("racks", "cassettes", etc.) and an integral diffuser assembly.

L. Membrane Cartridge: The smallest assembled unit of a delivered system that is designed to be removed from a SMU and replaced as a complete unit. This may be flat sheets attached to a support structure and may be referred to as a "module", "cassette", or other terms.

M. Plant Hydraulic Loading Criteria: The net permeate flow rate over a given period of continuous operation accounting for CIP procedures and relaxation. Production capacity requirements are given in terms of:

1. Average Annual Flow (AAF): The net daily flow requirement generally occurring during dry weather conditions.

2. Maximum Monthly Flow (MMF): The net daily flow requirement generally occurring during wet weather conditions.

3. Peak Week Flow (PWF): A net weekly flow total generally occurring during wet weather conditions

4. Peak Daily Flow (PDF): The net daily flow required during peak daily flow conditions.

5. Peak Hourly Flow (PHF): A net peak hourly flow requirement generally occurring during wet weather flow conditions.

6. Peak Instantaneous Flow: The highest allowable flow rate under any conditions.

N. Flux: Gallons of permeate flow per day per square foot of membrane area (gfd). Additional definitions of flux that are used to characterize design criteria and membrane performance include:

1. Instantaneous Flux: Calculated by dividing measured permeate flow rate by working membrane area at any instant.

2. Gross Flux: See Instantaneous Flux.

3. Net Flux: Calculated by dividing the total amount of permeate produced (available for discharge) in a given time frame by the working membrane area.

O. Backwash: Synonymous with back pulse and back flushing. Backwashing is any instance where water and or a chemical solution are charged to membranes in the reverse direction of permeate flow with a membrane soak time less than 0.5 hr. A Backwash is performed in–situ and in mixed liquor or activated sludge. Typical backwash characteristics are provided below.

Summary of Backwash Characteristics		
Parameter	**Value (Condition)**	**Type**
Membrane Soak Time	≤ 0.5 hr	Primary
Conducted In Mixed Liquor	Yes	Primary
Conducted In–Situ	Yes	Secondary
Typical Duration	15–60 sec	Secondary
Fill Direction	Reverse	Secondary
Tank Fill/Drain	No	Secondary
Chemicals Required	No	Secondary

P. Maintenance Clean: Synonymous with chemically enhanced backwash and CIP. A Maintenance Cleaning is performed in–situ and in mixed liquor or activated sludge. The procedure is conducted by charging cleaning chemicals to membranes in the reverse direction of permeate flow with a soak time lasting more than 0.5hr. Typical Maintenance Cleaning characteristics are provided below.

Summary of Maintenance Cleaning Characteristics		
Parameter	**Value (Condition)**	**Type**
Membrane Soak Time	> 0.5 hr	Primary
Conducted In Mixed Liquor	Yes	Primary
Conducted In–Situ	Yes	Secondary
Typical Duration	0.5 hr – 2.0 hr	Secondary
Fill Direction	Reverse	Secondary
Tank Fill/Drain	No	Secondary
Chemicals Required	Yes	Secondary

Q. Recovery Cleaning: Synonymous with intensive cleaning and CIP. A Recovery Cleaning is performed in–situ or ex–situ and in water or dilute chemical. The procedure is conducted by charging cleaning chemicals to membranes in either direction with variable soak times. Typical Recovery Cleaning characteristics are provided below.

Summary of Recovery Cleaning Characteristics		
Parameter	**Value (Condition)**	**Type**
Membrane Soak Time	Optional	Primary
Conducted in Mixed Liquor	No	Primary
Conducted In–Situ	Optional	Secondary
Typical Duration	6.0 hr – 24.0 hr	Secondary
Fill Direction	Optional	Secondary
Tank Fill/Drain	Optional	Secondary
Chemicals Required	Yes	Secondary

R. Mechanical Cleaning: Synonymous with manual cleaning, physical cleaning and hand cleaning. Mechanical Cleaning is any instance where membranes are cleaned by hand or machine (water jetting or other) for the purposes of removing fouling or localized dewatering.

S. Localized Dewatering: Synonymous with clogging, sludging and plugging. Localized dewatering is the excessive accumulation of solids at a membrane surface in the form of refractory cake and generally in discrete, localized areas. Often caused by excessive filtration in combination with unequal or inadequate air scouring.

T. Days: Defined as calendar days.

U. In–Situ: Inside the normal service area and submerged in mixed liquor.

V. MLSS: Mixed liquor suspended solids reported as mg/l.

W. Permeability: Equals the instantaneous flux rate divided by the transmembrane pressure (TMP). The units of permeability are gfd/psi.

X. Relaxation: A temporary suspension of membrane filtration with continued .air scouring for the purpose maintaining treatment capacity or reducing CIP requirements.

Y. Transmembrane Pressure (TMP): The effective pressure differential across the membrane during normal operation.

1.03 DESCRIPTION OF WORK

A. This Section specifies the requirements for the furnishing, testing, training, Startup, and Warranty Support of all process equipment required for upgrading the Travis Field WWTP submerged membrane bioreactor system for the treatment of wastewater. A separate Membrane Bioreactor Thickener System (MBT) shall be included as part of the treatment process.

B. The MBR/MBT System Supplier shall furnish and commission the MBR System as described in this specification, inclusive of all equipment, instrumentation, scope–specific piping systems, controls, integration, and warranty support.

C. The MBR/MBT System Supplier shall provide the MBR Product Engineering and Design Services in support of the treatment system design as described in this specification.

D. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the MBR System in accordance with the installation instructions provided by the Supplier. Once installed, the MBR System shall be complete and operational with all control equipment and accessories as specified herein and described in the Contract Documents.

E. The Engineer shall decide as to the quality and acceptability of services and materials furnished and Work performed. All questions which may arise as to the interpretation of any or all Plans and Specifications and all questions as to the acceptable fulfillment of the Contract on the part of the Contractor and Suppliers shall be resolved by owner and the Engineer.

F. The MBR/MBT System Supplier must clearly identify in detail any and all exceptions to the Services and Scope of Supply described in this Specification.

1.04 SUBMITTALS

A. Project Submittal: The MBR/MBT System Supplier shall submit to the Contractor the complete descriptive information for all equipment, instrumentation, and component in the Supplier's Scope of Supply (A copy of the MBR/MBT supplier's scope is provided as an exhibit) prior to purchase of equipment. The Project Submittal shall contain the following:

1. Membrane installation drawings, detailing membrane unit dimensions, materials, weights, locations of lifting lugs/points, and anchor bolt locations.

2. MBR/MBT basin mechanical layout drawings, detailing the number of membrane units, air and permeate piping distribution, piping supports, in–basin instrumentation and valves, and all other components comprising the MBR basin systems. Drawings with detail information in plan and elevation/section views and include details as necessary to completely describe the installation requirements. Drawings will be based on the basin/structural design provided by the Engineer.

3. Plan view equipment and instrument drawings showing the location of all components provided by the MBR/MBT System Supplier. Locations and installation details are to be coordinated with the Engineer's drawings to avoid conflicting information.

4. MBR/MBT System Supplier's literature for all equipment in scope of supply will include (as applicable):

   a. Pump curves

   b. Blower curves

   c. Mixer velocity distribution profiles

   d. Materials of construction

   e. Shop drawings showing all dimensions, sizes and locations of anchors

   f. Minimum, maximum, and design duty points for all equipment including pumps, blowers, mixers, etc. (flow rates and pressures/TDH)

   g. Unit performance and efficiency data

   h. Motor horsepower and voltage

   i. Complete wiring and control diagrams which show the point of connection for the power supply and control system

   j. All project–specific installation data for use by the Contractor.

5. Where manufacturers' standard literature is submitted, it shall be clearly marked to indicate which features are to be furnished under this contract.

6. Process and Instrumentation Diagrams (P&IDs) showing all equipment and instrumentation which will be controlled by the MBR System Supplier control system, including components provided by others.

7. Instrumentation list and manufacturers' literature and cut sheets, clearly identifying manufacturer, models, ranges, features, materials of construction, installation details, power supply voltage, wiring information.

8. Valve list and manufacturers' literature and cut sheets, clearly identifying manufacturer, models, Cv range, orientation, flow direction, materials of construction, pressure rating, and dimensions.

9. Valve actuator manufacturers' literature and cut sheets, clearly identifying models, motor horsepower and voltage, control wiring, installation/connection details, torque rating, actuation times, duty cycle, and materials of construction.

10. Control panel drawings, detailing the interior and exterior layouts, components, panel dimensions, panel materials of construction and NEMA rating.

11. Control panel component manufacturers' literature, clearly denoting model numbers of all PLC components, relays, terminal blocks, power supplies, buttons, switches, fuse blocks, etc.

12. Control panel wiring schematics.

13. Warranty information, detailing membrane design fluxes for all flow conditions.

14. System start–up and test procedures.

15. Provide a List of Scope of Supply for the entire system, that clearly shows the number of all equipment supplied by the system supplier to include the # of duty and spare.

B. Installation and Operations Manual (IOM): The MBR/MBT System Supplier shall furnish an Installation and Operations Manual at least 2 to four weeks prior to the delivery of the Supplier's equipment on site. The IOM will include Supplier and manufacturer's manuals and drawings detailing dimensions, locations, wiring information, and any other information necessary to convey the correct assembly and installation of the MBR System components provided by the Membrane Manufacturer and MBR System Supplier. In addition to installation documents, the IOM shall include requirements for the Mechanical Inspection and a schedule of events for the System Commissioning. The Supplier is to provide three hard–copies and two flash drives containing all information organized by component.

C. Plant Operations Manual (POM): The MBR/MBT System Supplier shall furnish a Plant Operations Manual within 2–4 weeks before completion of the System Commissioning. The supplier is to provide three hard copies and two CDs containing the following information:

1. HMI (operator interface) User's manual, detailing screens and functions within the operator interface program.

2. Process variables and final control narrative

3. As–built P&IDs

4. As–built electrical schematics and control panel drawings

5. Safety guidelines

1.05 QUALITY ASSURANCE

The MBR/MBT System supplier shall be Kubota Membrane USA (KMU).

A. All the equipment and services specified under this Section shall be furnished by the Membrane system supplier and shall be standard units of proven ability as a competent organization that is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

B. All membranes furnished under this Section shall be new and unused and shall be the standard products of a Membrane Manufacturer having a successful record of manufacturing the flat plate/flat sheet membranes specified herein for a minimum of **fifteen** (15) years.

C. The membrane sheet, module construction, membrane pore size, polymeric materials utilized shall have a successful operation and proven track records.

1.06 WORK BY GENERAL CONTRACTOR

A. The following work and scope of supply is specifically excluded from the MBR Supplier scope:
   1. Construction of:
      a. Operation & Auxiliary building
      b. Buried pipe, including soil requirements, thrust blocks, galvanic protection
      c. Concrete basins
      d. Wall penetrations
      e. Support of piping outside of MBR scope
   2. Structural:
      a. Building(s) for housing MBR.
      b. Concrete tankage for process and membrane zones.
      c. Imbedded wall spools, pipe sleeves, pipe seals in concrete tank walls for the various process pipe connections/penetrations.
      d. Covers or grating over process and membrane zones.
      e. Equipment access platforms, walkways, stairs, etc.
      f. Protective coatings for concrete.
      g. Anchor bolts for any equipment outside of MBR basin.
   3. Mechanical:
      a. Mixed liquor recycle piping, including branch connections and headers.
      b. Membrane CIP piping, including branch connections and headers.
      c. Pipe supports and hangers unless otherwise noted.
      d. Hoist equipment above the membrane basin for installation and removal of the membrane subunits.
      e. Membrane tank drain piping, valves, operators, and pumps, if required.
      f. Installation of any kind, including equipment and piping within or outside of Scope of Supply.
      g. Installation materials for instrumentation and automatic valves, including, but not limited to, air / sample line tubing, fittings, and mountings.
   4. Electrical:
      a. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from the electrical power source to the MBR System Control Panel.

b. Electrical wiring interconnections (including wiring, conduit and other appurtenances required to provide power connections as needed) from MCC and/or Panelboard(s) to all field equipment.
c. Instrumentation wiring, conduit and other appurtenances required to provide connections as needed between all field devices and the membrane PLC control panel or MCC.
d. Motor control centers, Variable Frequency Drives (VFDs), panel boards, transformers, and other equipment necessary to provide power distribution for equipment, unless specifically listed in **2.03** SUBSYSTEM SCOPE OF SUPPLY.
e. Network communications connections, conduit, wiring or fiber optic cable including fiber terminations to the Plant SCADA and the MBR System SCADA systems (if the two are different). Includes network communications connections from PLC control panels to remote I/O control panels.
f. Internet network provisions to permit remote access of MBR Control System.

5. Other Misc. Items:
   a. Receiving, unloading and safe storage of equipment at site or a storage facility until ready for installation.
   b. Equipment installation.
   c. Instrumentation installation including continuity checks and assistance with related loop checkout.
   d. Raw materials, chemicals and utilities during equipment testing. This includes potable water for system function testing and seed sludge per supplier requirements.
   e. Laboratory services, operating and maintenance personnel during equipment checkout, startup and operations.
   f. Onsite painting or touch-up painting of MBR, with the exception of painting required due to damage incurred prior to equipment being received onsite.
   g. **Seed Sludge** – Contractor to provide approximately 150,000 gallons of seed sludge for commissioning of the plant. The sludge shall be from a healthy activated sludge plant (preferably an MBR plant) at a minimum concentration of 1%. (no digester sludge).

1.07 WARRANTY

A. MBR/MBT Manufacturer and System Supplier shall provide a guaranteed membrane replacement or additional purchase price as a cost per membrane module. Price shall be for membrane cassette only and shall not include associated air scour diffuser case.

B. MBR/MBT System Supplier shall warranty and replace the membranes under warranty for a period of 10 years. The warranty shall not be pro-rated.

C. All warrantee support, as defined in the warranty statement, shall be provided by the MBR/MBT System Supplier (Kubota, USA) directly.

D. MBR/MBT System Supplier shall warrant small membrane subunits under the following terms:

   1. MBR/MBT System Supplier shall replace any small membrane Subunits that fail before 10 years (Not Prorated) from the date of successful completion of the System Commissioning and acceptance by City as specified herein.

2. Failure is defined as any of the following:

   a. Inability to meet production capacity requirements as specified herein.

   b. Inability to meet TSS and turbidity requirements as specified herein.

   c. Failure to meet MBT sludge concentration.

   d. Visual damage to membrane plates or sheets during normal operations and within membrane system supplier's guidelines. Examples of visual damage include plate breakage and membrane sheet separation. Plates or sheets with observed visual damage shall be fully replaced, regardless of whether or not membrane system is meeting effluent turbidity limits.

3. The following are specifically excluded from warranted membrane failure conditions:

   a. Exceeding TSS or Turbidity limits due to accidental physical damage of the membranes and/or loss of piping integrity.

   b. Loss of capacity due to failure to operate within design fluxes and permeability limits as defined in this Section.

   c. Loss of capacity due to failure to perform required Maintenance cleans.

E. Supplier shall warranty all other equipment, not specifically mentioned above, against defects in workmanship and materials for a period of 1 year. The warranty period shall begin following completion of the System Commissioning and acceptance by City as specified herein.

PART 2 - PRODUCTS

2.01 MBR PRODUCT ENGINEERING AND DESIGN SERVICES (Provided During Design)

A. The MBR Manufacturer and System Supplier will provide the following design services related to the MBR product to the Engineer during design process:

1. Biological Process Design Verification – The MBR Supplier shall support the Engineer in providing analysis and verification of the biological process design, based on the customer's influent mass loading, diurnal flow curves (if available), peak flow/loading numbers, and permit limits. The Supplier shall verify basin volumes, recycle rates, aerations requirements, chemical dosing requirements, and waste solids projections. The supplier shall provide a written report summarizing the design results.

2. Piping Hydraulic Analysis and Design – The MBR Supplier shall provide a detailed hydraulic analysis and mechanical design documentation of each process subsystem contained in the MBR System scope of supply. Piping design CAD files shall be provided to the Engineer for integration into the design package. The subsystems included in the hydraulic analysis shall include:

   a. Recycle pump systems

b. MBR air distributions systems

c. Permeate systems

d. WAS systems

3. Equipment Sizing and Installation Details – The MBR Supplier shall verify duty points and turn–down, supply voltages, materials of construction, communications IO, equipment access and serviceability, area classifications, and pressure ratings for the MBR System's pumps, blowers, mixers, and valves. In addition to identifying manufacturers and specific part numbers for each component, installation details and CAD drawings shall be provided for integration into the Engineer's design package.

4. Instrumentation Design – The MBR Supplier shall provide the Engineer with complete specification and documentation of all MBR System instrumentation. Installation details shall be provided in AutoCAD format for integration into the Engineer's design package.

5. Controls Design – The MBR Supplier shall supply MBR System Process and Instrumentation Diagrams utilizing the Supplier's standard symbols and tagging schemes,

2.02 SYSTEM PERFORMANCE REQUIREMENTS

A. The MBR System will be sized to hydraulically convey the flows shown in Table 2–1.

Table 2–1: Plant Hydraulic Loading Criteria

Parameter	Influent		Event Duration	Frequency	Total Duration
Average Annual Daily Flow (AAF)	4.0	MGD	365 days	1/ year	265 days
Maximum Month Daily Flow (MMF)	4.0	MGD	30 days	3/ year	90 days
Peak Daily Flow (PDF)	8.0	MGD	24 hours	9/ year	9 days
Peak Hourly Flow [1]	7,000	GPM	2 to 4 hours	24/year	2 days

[1]- Max flow to MBR will be equalized to 8.0 MGD through Equalization pump station

B. The MBR System shall be designed to accommodate the diurnal pattern as indicated per Engineer.

C. The MBR System shall be capable of treating raw wastewater at listed flows to the specified effluent criteria shown in Table 2–2 & Table 2–3

Table 2–2: Travis Field WPCP Influent Criteria

Parameter	Annual Average Conditions	Maximum Month Conditions
cBOD5, mg/L	170	255
BOD, mg/L	200	300
COD, mg/L	435	653
TSS, mg/L	160	240
TKN, mg/L	33	40
NH3–N, mg/L	24	29
TP, mg/L	5.3	8.0
Design Temperature, °C	24	17
Alkalinity, mg/L CaCO3	185	185

Table 2–3: Travis Field WPCP Effluent Criteria

Constituent/Parameter (1)	Limits	
Effluent Flow Rate (MGD)	4.0	8.0
Five–Day Biochemical Oxygen Demand (mg/l)	10.0	5.0
Ultimate Oxygen Demand (lbs./day)	2,043.0	2,043.0
Ammonia, as N (mg/l) March–October November– Feb.	 2.0 4.0	 1.0 2.0
Dissolve Oxygen, Min. (mg/l)	5.0	5.0
Total Suspended Solids (mg/l)	20	20
Fecal Coliform Bacteria (count/100mL, geometric mean)	200	200
Total Phosphorus, as P (mg/l)	0.5	0.5
Total Residual Chlorine (TRC) (daily max) (mg/l)	0.28	0.14
pH (standard units)	6.0–9.0	6.0–9.0

(1) Values are maximum monthly average except as noted

D. System Configuration

1. The MBR System shall consist of:

   a. Anaerobic, Anoxic, Pre–Aeration and MBR basins.

   b. System must include 4 MBR zones and process 75% of Avg Day Flow with 1 basin out of service.

   c. MLSS range shall be 6,000 mg/l to 13,000 mg/l and shall be selected by MBR system supplier and shall be appropriate for membrane technology utilized.

   d. Total system HRT shall be no less than 7 hours at 4 MGD design flow condition

   e. Total HRT shall include volumes of Anaerobic, Anoxic, Pre–aeration and Membrane Zones. Design calculations provided shall verify HRT requirements are met.

f. Total System SRT shall be no less than 16 days at 4 MGD design flow condition. SRT shall assume a sludge yield factor of 0.75 lbs WAS/lb BOD applied from influent at Avg. day flow conditions. Design calculations provided shall verify HRT requirements are met.

2. The MBT system shall consist of:

a. One in-loop digester basin with a minimum volume of 246,000 gallons.

b. One isolated digester basin with a minimum volume of 65,000 gallons

c. One MBT thickener basin with a minimum volume of 21,000 gallons.

d. The MBT Thickener system shall include one membrane zone, one stage one, and one stage two digestion zone. WAS shall be thickened to 4% within the MBT system. A minimum of 20 days SRT at design conditions (4 MGD– see table 2.1 and 2.2 above) shall be provided. A sludge yield of 0.75 lbs. WAS/lb. BOD influent shall be utilized.

E. The proposed MBR System shall be designed in conformance to design guideline specified by submerged membrane unit (SMU) manufacturer.

F. The allowable MLSS concentration in the Membrane Zones shall range between 8,000 mg/l and 13,000 mg/l.

G. The allowable MLSS concentration in the MBT zones shall range from 8,000 mg/l to 40,000 mg/l.

H. The MBR basins shall be considered part of the biological process when calculating aerobic volume requirements.

I. Membrane CIP Procedures

1. Membrane subunits shall be cleaned in place using CIP methods to maintain production capacity and meet performance requirements specified herein. The allowable frequency of listed CIP methods shall be as follows:

a. Maintenance Clean frequency shall be as needed

b. Recovery Clean frequency shall not exceed 4/yr. (if Needed)

J. Not Used

K. The MBR shall be designed to operate at or below a trans-membrane pressure (TMP) of 3 psig.

L. The MBR System shall utilize self-priming centrifugal pumps to filter water.

M. Membrane Integrity Testing

1. Online membrane integrity testing shall be provided for each MBR zone.

N. Site Conditions

1. The elevation above sea level is 50 ft.

2. Influent wastewater shall contain less than 15% of the influent BOD_5 as fats, oils and grease (FOG).

3. No substances shall be placed in the system in quantities which are not biodegradable or toxic to the biological system.

4. The influent wastewater pH shall be between 6–8 SU.
5. Water hardness shall not exceed 300 mg/l as $CaCO_3$.

2.03 SUBSYSTEM SCOPE OF SUPPLY

MBR System Supplier shall furnish the Subsystem Components listed below in accordance with the requirements of this the project Specifications and Contract Documents. All components shall be shipped loose for installation by installing Contractor unless otherwise noted.

A. Anaerobic Basins,
   1. Mixers
   2. Basin high and low–level switches

B. Pre–Anoxic Basin
   1. Mixers
   2. Basin high and low–level switches
   3. Basin level sensor/transmitter

C. Pre–Aeration Basins
   1. Basin high and low–level switches
   2. Fine bubble diffusers
   3. Combination DO/temperature sensor/transmitter

D. Post–Anoxic Basins
   1. Mixers
   2. Basin high and low–level switches

E. Membrane Basins
   1. Membrane– Submerged Membrane Unit (SMUs)
   2. In–basin interconnecting air and permeate piping four (4) inches in diameter or less. In basin air and permeate **header** piping shall be supplied by installing contractor.
   3. Stainless steel pipe supports and support anchors for all Supplier–provided piping.
   4. Basin high and low–level switches.

5. Include air and permeate isolation valves as needed

F. MBT System
   1. Membrane– Submerged Membrane Unit (SMUs)
   2. In–basin interconnecting air and permeate piping four (4) inches in diameter or less. In basin air and permeate **header** piping shall be supplied by installing contractor.
   3. Pipe supports and support anchors for all Supplier–provided piping.
   4. Basin high and low–level switches.

5. Diffusers and in basin manifold piping for mixing of WAS solids at high concentrations.

G. Permeate Collection System

1. MBR/MBT permeate pumps
2. MBR/MBT permeate control valves
3. MBR/MBT Permeate process instrumentation
4. MBR Permeate turbidimeters (one per basin)

H. Cleaning Systems (for MBR and MBT Systems)

a. Maintenance Clean system pumps, valves, instrumentation, and tanks. Maintenance Clean shall be semi-automatic (fully automated skid) (when needed, operator shall be able to initiate the MC by simply pushing a button at the CIP skid and manually close the permeate valve and open chemical injection valves at each basin. All other valves, chemical injection, functions, etc. shall be automatic).

2. Backwash system pumps, valves, instrumentation, and tanks. Back pulse equipment shall be skid mounted for simplified installation. All required valves, actuators, back pulse tanks, pumps etc. shall be provided by MBR system supplier as part of the back–pulse skid.

3. Recovery Clean system pumps, valves, instrumentation, and other ancillary equipment as needed.

4. The **General Contractor** to provide one (1) Poly-processing 1,400 gallon 1.9SG XLPE Natural close top vertical Cylinder tank with (2) 2" 150# flanges connection for CIP storage tank. The tank shall be max 6 ft. in diameter.

I. WAS Handling System

1. WAS Pumps
2. WAS control valves
3. WAS instrumentation

J. Supplemental (Process) Aeration System

1. Process air blowers with one standby of equal or greater capacity

K. Membrane Zone (Scour) Aeration System (MBR and MBT)

1. Scour air blowers with one standby of equal or greater capacity
2. Scour air flow control valves
3. Scour air instrumentation

L. Internal Recycle System

1. RAS pumps with standby of equal capacity
2. RAS flow control valves (supplied by the contractor)
3. RAS instrumentation
4. Flow mag meters (numbers as needed)

M. Controls

1. MBR/MBT PLC control panel and if applicable remote I/O control panel(s)

2. MBR/MBT Human–Machine Interface (HMI) Computer and runtime software licensed to Owner

3. HMI and PLC programming

2.04 GENERAL EQUIPMENT DESIGN AND FABRICATION REQUIREMENTS

The requirements listed below are in addition to those called out in the Specifications listed in Part 1.01 of this Specification.

A. Submersible Mixers

1. Submersible mixers shall be direct driven, close–coupled, guide–rail–mounted, non–clogging propeller type designed for mixing of raw or processed sewage. All components of the mixer shall be capable of continuous submerged operation. The mixer shall be sized to provide complete mixing.

2. All major components of the submersible mixers shall be manufactured of 316 stainless steel. All bearings shall have a minimum B–10 rated bearing life of 100,000 hours.

3. Mixers shall have integral motor thermal overload protection and seal failure (moisture) sensor.

4. The mixers shall be provided with guide rails, guide brackets, and lifting cables.

B. Mixed Liquor Recirculation Pumps

Note: All submersible pumps regardless of size and location in the MBR system shall be manufactured by Flygt (Xylem). No other submersible pump is acceptable.

1. Mixed liquor recirculation pumps shall be capable of passing a three–inch spherical solid.

2. Major pump components shall be cast iron, ductile iron, or stainless steel.

3. Pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansion joints.

4. Submersible pumps: Pumps shall have integral motor thermal overload protection and seal failure (moisture) sensor and be provided with guide rails, guide brackets, and lifting cables.

5. Dry–mount pumps: Pumps shall be horizontal, self–priming centrifugal type, designed specifically for handling municipal waste.

C. Fine Bubble Diffuser Systems

1. Fine bubble diffuser systems shall include in–basin aeration piping, submerged manifolds, laterals, diffusers, drain pipes, pipe supports, and purge system. Major air header piping at the top of the basins along with air drops to diffuser manifolds shall be provided by installing contractor.

D. Submerged Membrane Unit (SMU)

1. The MBR SMUs shall be the SP600 type as manufactured by KUBOTA. The MBT SMUs shall be RM200 type as manufactured by Kubota. Due to high MLSS concentrations within the MBT system, the maximum flux rate for MBT membranes shall be capped at 10 gfd.
2. The SMUs and supporting pipe work shall be designed for a cross–flow configuration by which the system will remove a portion of the water as the recycle flow circulates through the Membrane Zone.
3. Membrane Zone can be classified as an MBR or a Membrane Tank.
4. Each Membrane Zone shall include one or more Membrane Banks.
5. Each Membrane Bank shall consist of one or more Submerged Membrane Units (SMU). Each SMU shall be:
    a. Prefabricated, preassembled and factory certified before shipment to the site.
    b. Provided complete, with all necessary components, accessories and appurtenances required to make a complete and operable system.
    c. Furnished with 304 SS housing, appurtenances and fasteners (including nuts, bolts, screws, cables, washers).
    d. Furnished with integral diffusers designed to promote efficient air scouring of Membrane Elements. The diffuser must be manufactured by membrane manufacturer.
    e. Equipped with one or more SMU Subunits.
6. SMU Subunits contain multiple Membrane Elements. Membrane Elements shall:
    a. Be assembled into a housing called a cassette or other.
    b. Be constructed such that the membranes are held vertically and bonded firmly at the top and/or bottom of the Subunit.
    c. Be manufactured using materials suitable for use in submerged MBR applications and:
        i. Have an average pore size of 0.2 micron or less for Kubota.
        ii. Be physically strong enough to withstand the operating conditions associated with continuous operation in an aerated tank of mixed liquor at concentrations of up to the value as specified by SMU manufacturer in its operation manual.

E. Permeate Pumps

1. Permeate pumps shall be required when the hydraulic loading as described in this Specification cannot be met using gravity flow.
2. Permeate pumps shall be sized to handle peak instantaneous flow as defined in this Specification as well as rates associated with backwashing, maintenance cleaning, and aerator flushing.
3. Permeate pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansion joints.

4. Permeate pumps shall be horizontal, self–priming centrifugal type or rotary lobe type, designed specifically for handling municipal waste.

F. Blowers

1. Blowers shall be provided complete with sound enclosure, inlet filters, discharge silencers, pressure relief valves, check valves, motors, temperature and pressure gauges, over–temperature sensor/switch, expansion joints, belts, and baseplates.

2. To facilitate simplified MBR basin operations, each MBR basin shall have a dedicated blower. A common standby blower shall also be provided.

3. Process aeration blowers shall be sized to maintain a residual DO of 2.0 mg/L at MMF flow rates and loadings and a minimum of a 2:1 turndown. Process aeration system shall include a standby blower of equal or greater capacity than the duty blowers.

4. MBR/MBT scour air blowers shall be sized such that sufficient scour air is provided to support MMF flows as described in this Specification without requiring additional maintenance cleans. The scour air system shall include a standby blower of equal or greater capacity than the duty blowers.

5. MBR/MBT scour air blowers shall accommodate a minimum surge of 1.5 psig under normal operating conditions.

G. Cleaning Systems

1. The Cleaning Systems shall include backwash, maintenance clean, and recovery clean systems as required by the Supplier's specific systems. CIP system shall be skid wall mounted.

2. A written statement from the Membrane Module Manufacturer must be included which confirms that all flux rates and CIP systems provided herein are in compliance with Membrane Manufacture's recommendations.

3. Cleaning Systems shall be <u>SEMI–AUTOMATIC</u> and inclusive of all chemical feed tanks, chemical feed pumps, valves, instrumentation, controls, and all other ancillary equipment necessary for a complete cleaning operation.

H. Waste Activated Sludge (WAS) Pumps

1. WAS pumps shall be capable of passing a three–inch spherical solid.

2. The pumps shall be sized to transfer the expected MMF waste sludge volumes in less than 3 hours.

3. Major pump components shall be cast iron, ductile iron, or stainless steel.

4. Pumps shall be provided inclusive of check valves, isolation valves, inlet and outlet pressure gauges, and expansions joints.

5. WAS pumps: WAS pumps shall be self-priming centrifugal pump.

6. Dry–mount pumps: Pumps shall be horizontal, self–priming centrifugal type or rotary lobe type, designed specifically for handling municipal waste.

I. Not Used

J. Valve Actuators

1. In order to reduce operating noise levels to nearby residents, it is preferred that all valves be electric actuated valves. Valves must have On/Off Manual options, at the valve and in SCADA.

K. Piping

1. All MBR System air scour piping, on the inlet side, shall be Type 304 stainless steel schedule 10, until the piping become submerged in the MLSS. The air scour piping on the outlet side may be schedule 80 PVC, as submergence in the MLSS will have cooled the process air, reducing thermal stress on the piping.
2. Permeate piping shall be schedule 80 PVC within the MBR tanks.
3. Piping shall have welded, glued, flanged, or mechanical groove (Victaulic) connections.
4. Pipe supports shall be 304 stainless steel Unistrut (or equivalent) systems, or 304 stainless steel angle and structural shapes with stainless hardware, clamps, and guides
5. Transitions from MBR Supplier piping to Contractor's piping shall use ANSI 150-pound flanges.
6. Insulation, heat tracing and or painting shall be provided by the Contractor.

L. MBR SYSTEM CONTROLS

1. The MBR/MBT System controls shall be housed in a NEMA 12 (indoor) unless otherwise specified. The control panel assembly shall be a UL 508a listed Industrial Control Panel. The control panel will house the MBR system PLC and I/O modules as necessary, and valve Open/Close/Auto switches. The panel shall include the following features:
   a. UL1449 listed Type1/Type 2 incoming power supply surge protective device capable of 50kA 8x20us
   b. Redundant 24 VDC power supplies connected through a protective diode such that failure of one power supply does not affect the other.
   c. PLC sized to handle all I/O for components in the MBR System as indicated on the P&IDs plus 10% spare I/O terminated to terminal blocks in each PLC or I/O panel.
   d. Power to each I/O module shall be fused. All instrument power fed from panel shall be fused per UL requirements.
   e. PLC user memory greater than 2MB and processor capable of connection to 32 Ethernet Nodes minimum.
   f. PLC, HMI and remote I/O devices shall connect via Ethernet/IP to an industrial managed Ethernet switch.
   g. System shall include a Phoenix Contact MGuard industrial VPN device for secure remote access.
   h. Control Panels shall include a pure sine wave UPS including UPS Maintenance/Bypass switch which permits seamless transfer of power to utility in case of UPS maintenance and relay contacts for UPS failure, on battery and low battery status.

2. The MBR System shall include one Human–Machine Interface (HMI), including Windows–based PC and HMI runtime software licensed to owner. System displays shall include graphical representations of all equipment and instrumentation and indication and trending of all process values.

3. The Supplier shall be responsible for all programming for the MBR System PLCs, database creation, generation of all graphic display screens, alarm configurations and trends for the operator stations.

4. MBR System controls shall be designed to allow for full manual (hand) operation in the event of PLC failure. Hand operations shall be manageable by two operators for a period of 72hrs.

M. Spare Parts.

Equipment	**Description**	**Manufacturer**	**Qty**
Blower	Filter elements, Bearing Seal	Per Bid Specs	2 sets
Feed forward pump	Seals, Bearings, O–rings	Per Bid Specs	2 sets
Anoxic Mixer	Repair Kit, Seals, Bearings, O rings	Per Bid Specs	2 sets
Permeate pump	Spare parts kit	Per Bid Specs	1 set
DO/ temp meter	Kit Sensor Cap replacement, LDO	Per Bid Specs	2
Level Transmitter	Full unit	Per Bid Specs	1
Level Switch	Full unit	Per Bid Specs	1
Pressure Transmitter	Full unit	Per Bid Specs	1
Turbidity meter	Lamp Assy, 1720D/E	Per Bid Specs	1
Actuators	Permeate Flow Control Valve	Per Bid Specs	1
Controls	Spare relays	Per Bid Specs	1 set
	Spare power supply	Per Bid Specs	1 set
	Panel mounted instruments, lights, push buttons	Per Bid Specs	1 set
	Spare Fuses	Per Bid Specs	1 set
	Indicating lights, bulb lights	Per Bid Specs	1 set

PART 3 - EXECUTION

3.01 MBR PRODUCT ENGINEERING AND DESIGN SERVICES (Provided During Design)

3.02 PROJECT EXECUTION

A. Unless otherwise required in the Contract Documents, the MBR Supplier shall provide all submittal documentation as described in this Section no later than 10 weeks after receipt of fully executed purchase order from the general contractor.

B. Unless otherwise required in the Contract Documents, the MBR Supplier shall deliver all components in their Scope of Supply, as described in this Section, no later than 36 weeks after receipt of written submittal approval.

C. Contractors must provide proof of adequate Payment Bond and Performance Bond before contracts will be finalized.

D. Startup and Commissioning Notes for General Contractor

During plant start-up, the General Contractor (GC) is responsible for providing Kubota field support technicians with sufficient support personnel to address any startup issues. The plant personnel are encouraged to participate in the start-up process. Operator participation during start up enhances confidence and speeds up the learning curve and allows for an easier transition upon assuming responsibility of the facility.

The general contractor is responsible for properly scheduling construction and startup activities. A normal workday during startup is 10 hours M-F. Kubota's startup team will include Project Manager, Startup Technician and Controls specialist. The Kubota Project Manager will remain as the primary point of contact for issues related to scope of supply, payments, change orders and other required tasks. Kubota is only responsible for scheduling personnel based on Kubota's scope of supply.

3.03 CONTROL SYSTEM FACTORY ACCEPTANCE TEST

A. The MBR/MBT System Supplier shall coordinate and conduct a factory acceptance test (FAT) of the MBR control system during which:

1. The PLC control logic and HMI operability shall be demonstrated by systematically forcing I/O to verify all controls functions and HMI screen representations defined in the system control narrative.

2. The MBR control panel shall be inspected for completeness, and workmanship.

B. The MBR System Supplier shall provide a minimum of 2 weeks' notice to the Owner and Engineer prior to the FAT. The Owner and Engineer may, at their option and their expense choose to attend and witness the FAT.

C. Whether or not the Owner and/or Engineer attend the FAT, the MBR Supplier shall provide written documentation and certification of the completed FAT.

3.04 MATERIALS INSPECTION (Kubota Technician on Site 2 trips 4 days)

A. The Contractor shall inspect delivered equipment upon arrival on site for completeness of scope delivery and to verify that all components have arrived undamaged. The Contractor is responsible for notifying the Supplier of deficiencies in quantities or conditions within 28 days from the ship date.

B. The Contractor shall provide all labor, materials, and equipment for unloading, de–crating, organizing, and compiling lists of received MBR equipment, components, and instrumentation.

C. The MBR Supplier shall make available, upon the request of the Contractor, personnel to assist in the inspection of the Supplier's equipment upon unload at the site. Supplier's personnel shall provide services in accordance with their standard daily rates.

D. Membrane Storage - The acceptable temperature range for membrane modules is 40˚F to 104˚F (indoor room temperature). Long-term exposure to direct sunlight may cause damage to the membrane material and should be avoided. Ideally, the membranes will be delivered to the jobsite once all construction related items for the MBR basins are completed so that time between delivery and installation of the membranes is minimized. Installing contractor is responsible for proper storage of membrane modules from time of delivery to time of installation and commissioning. Kubota project manager will work with the contractor team to coordinate an optimal delivery schedule, but contractor may want to consider short term storage of membranes near the jobsite if required.

3.05 MECHANICAL & ELECTRICAL INSPECTION (Kubota technician on site 1 trip 5 days)

A. The Contractor shall schedule with the MBR System Supplier to perform a Mechanical Inspection at least 2 weeks prior to the scheduled Commissioning of the System.

B. The MBR Suppler shall conduct a Mechanical Inspection of the MBR System to verify that the installation is complete and ready to begin Commissioning activities. The Supplier shall verify the following:

1. Installation of all equipment per the Engineer's and Supplier's drawings and Supplier's IOM information.
2. Installation of all instrumentation per the Engineer's drawings and IOM information.
3. Completeness of all piping installations.
4. Completeness of all electrical installations.
5. Proper installation of the MBR SMU diffuser assemblies per the Submittal and IOM information.
6. Completeness of all basins, including removal of all debris that may cause damage to the MBR SMU membranes.
7. Review of all pipe integrity testing results.

C. Upon completion of the Mechanical Inspection, the Supplier shall provide written documentation of the inspection results.

D. Follow up to Mechanical Inspection

1. If the MBR System is complete per the requirements of the Mechanical inspection, the MBR Supplier shall schedule the System Commissioning with the Contractor. The date for the System Commissioning is to be established within 2 weeks of the successful completion of the Mechanical Inspection.

2. If the MBR System is not complete at the time of the Mechanical Inspection, the Supplier shall document system deficiencies to the Contractor, Engineer, and Owner. The Contractor will then complete all necessary work and provide documentation (including digital photographs) of the completed work.

   a. Electrical and Control System Documentation Requirements

      i. Wire ring–out documentation signed by electrician

      ii. Pictures of completed terminations (terminations by contractor) in field and PLC panel including wire labeling.

      iii. Documentation and pictures of completed network cabling, Ethernet cable termination and fiber optic termination and patching.

      iv. Documentation and pictures of all motor and valve terminations, motor cable Insulation resistance testing

   After all the noted deficiencies are resolved to the satisfaction of the Engineer, Owner, and Supplier, the date for the System Commissioning is to be established within 2 weeks.

3. If the Mechanical Inspection deficiencies are deemed as sufficiently important by the Supplier, Owner, or Engineer, the Contractor shall arrange for the Mechanical Inspection to be repeated at the Contractor's expense.

4. If electrical and control system wiring is incomplete prior to system commissioning scheduling, Contractor must complete all necessary work and provide documentation of the completed work (as described in 3.05 D. 2. Above). The Contractor must update the Engineer, Owner, and Supplier of the progress so that a revised system commissioning date can be organized as soon as possible. In this scenario, penalties for project delay will become the responsibility of the Contractor.

5. Basin and Piping Integrity Testing - Suction side leaks in the permeate system can create issues during startup and normal operations. Failure to properly test the permeate system piping can result in unplanned startup delays and result in additional Field Service / Startup charges. General contractor must complete piping and basin integrity testing prior to engaging in startup/commissioning services.

E. Wiring/Instrumentation & Control **(Kubota Technician on site 1 trip 4 days)**

Wire / Loop Checks - Working with the GC's and Kubota integrator, Kubota's personnel will functionally test all (Kubota Scope) system inputs/outputs points to confirm wiring. Remediation of wiring problems is the responsibility of the GC.

Confirmation of wiring between any non-Kubota scoped panels, mcc or switchgear will require support from the supplier of that equipment. Remediation of wiring problems is the responsibility of the GC.

Device Calibration – All Kubota scope instrumentation will be setup and properly calibrated.

F. Electrical Equipment

1- GC is responsible for ensuring oil and lubrication levels are appropriate in mechanical equipment.
2- Kubota Engineer shall generate Equipment Acceptance forms for each piece of Kubota supplied equipment.
3- Actuated valves/gates shall be tested for proper operation and response to the HMI controls
4- Pumps and blowers shall be inspected for proper installation, tested for rotation, and response to the HMI controls
5- Where supplied by Kubota, VFDs shall be configured to min/max speed and other operating parameters.

3.06 SYSTEM COMMISSIONING

A. The MBR System Supplier shall coordinate with the Contractor, Engineer, and Owner for execution of the System Commissioning. In advance of System Commissioning the MBR System Supplier shall perform an onsite Mechanical Inspection of the facility and generate a punch–list of inconsistencies. The Contractor is required to resolve the punch–list items to the satisfaction of the System Supplier, prior to scheduling System Commissioning. The System Commissioning will consist of the following:

1. General inspection of systems (lubrication, rotation, calibration).
2. Loop checking, instrumentation, and control system verification.
3. Clean potable Water diffuser testing.
4. Clean potable water permeates pipe loss testing.
5. Sludge re–seeding.
6. Training of the City staffs.

B. The Contractor shall provide materials and personnel in support of the System Commissioning to fill basins with clean water, transfer fluids, repair/remedy all electrical and mechanical issues, provide temporary tie–ins, temporary piping, transfer pumps, etc.

C. The Contractor shall coordinate with the Engineer and Owner and provide seed sludge to start the MBR System at the end of the clean water testing.

D. Contractor to provide approximately **150,000 gallons of seed sludge**. The seed sludge shall be approved by the MBR supplier. The sludge shall be from a healthy activated sludge plant (preferably an MBR plant) at a minimum concentration of 1%. (no digester sludge). The MBR Supplier is not responsible for supplying the seed sludge.

E. The System Commissioning shall begin at the Contractor's discretion, within the limits defined herein:

1. Successful completion of a pre–commissioning Mechanical Inspection is required.

2. Start of Commissioning shall be no later than 60 days after completion of Mechanical Inspection.

F. The Owner may assist the contractor to operate the plant during the Commissioning Period. The contractor is responsible for operation of the entire plant during the plant Commissioning. <u>The contractor shall engage a certified operator (approved by the MBR supplier) to operate the plant during commissioning and performance testing period and until the City acceptance of the plant.</u>

G. Supplier is responsible for monitoring operating conditions and performance during the Commissioning Period.

H. Supplier shall provide the Owner with a Plant Operations Manual <u>prior</u> to the Commissioning Period. The manual shall include at a minimum:

1. As–built drawings
2. Safety Manual
3. HMI User's Manual
4. As–built control schematics
5. Process variables and control narrative.

I. Supplier shall submit the Plant Operations Manual four weeks prior to the Commissioning Period.

J. Membrane permeate quality shall be evaluated to determine compliance of the MBR System with Performance Requirements. If the MBR System fails to comply with requirements of membrane permeate quality, Supplier at their expense shall provide the Owner and the Engineer a written plan of modifications to the system (such as repairing damaged membranes, replacing seals, complete replacement of system) to achieve compliance with the requirements. Upon implementation of modifications plan, the permeate quality tests shall re–commence in their entirety.

❖ **<u>Clean Potable Water Wet Testing (Kubota technician on site 1 trip and 5 days)</u>**

Wet testing is the process of operating all or some of the process basins with clean water, prior to exposing any systems to MLSS. The purpose of these tests is to prove the integrity and functionality of various elements of the treatment process including pumps, valves, flow channels, etc.

There are various requirements for clean water testing during an MBR system startup. Kubota utilizes clean water testing for the purposes of conducting Pipe Loss and Clean Water Flux testing and fine/coarse bubble diffuser testing.

Flat plate membrane is not intended for sustained operations in clean water. Exposing the membrane to long periods of permeation in clean water can result in a decrease in initial performance and result in unnecessary chemical cleans.

Pipe Loss Testing - Testing involves disconnecting the membranes units from the permeate piping and filling the system with clean water to the normal operating level. The permeate systems will then be operated pulling a suction directly from the MBR tank. Level in the MBR basin must remain constant during this test.

Clean Water Flux Testing – like Pipe Loss Test, except the membranes are connected to the permeate header. These tests are intended to be short term with permeation not exceeding a total of 3 hours for each membrane unit tested. Level in the MBR basin must remain constant during this test.

❖ **Seeding the MBR Process** <u>**(Kubota technician on site 1 trip and 5 days)**</u>

Seed sludge must be from an acceptable source, at an appropriate concentration, and in sufficient volume.

A fresh nitrifying activated sludge from a nearby WWTP should be used as the seed for the MBR process. Quality sludge will have characteristics of:

- VSS >70%
- Sour 1 – 10
- Filterability >10
- No chemical additives
- No mal-odors
- No septic content
- Avoid sludge with excessive long sludge ages to reduce risk of membrane fouling.

A Kubota Commissioning technician shall inspect the seed sludge prior to seeding the MBR plant. All seed sludge entering the MBR system must be run through the fine screens, regardless of whether or not the seed sludge is from another MBR plant. For proper operation, the MBR process requires that MLSS concentrations be at least 3,000 mg/L. Concentrations below 3,000 mg/L do not provide sufficient Biofilm to protect the membrane surface from the impact of colloidal particles and can result in decreased membrane performance. See below table for guidance.

<u>MLSS Concentration Guidelines</u>

0 – 3,000mg/L = No Permeate System Operation
3,000 – 6,000 = Permeate System Limited to ½ Design Flow
6,000 – 12,000 = Design Operation

During the commissioning and the initial SRT period, regular analysis of the wastewater and mixed liquor characteristics, as well as the permeate quality will be required to monitor the performance of the process. Contractor must make arrangements to test for the following parameters. Testing may be done on-site using portable equipment or by an accredited laboratory.

- DO (on-site).
- pH (on-site).
- Temperature (on-site).
- Conductivity (on-site).
- Mixed liquor filterability (on-site).
- SS, MLSS, MLVSS.
- BOD, COD
- Total, calcium and magnesium hardness (site specific requirement)
- Alkalinity

❖ **Process Maturation**

Process maturation is the period after seeding and commissioning of the first membrane tank(s) and before the plant can treat the design flows (ADF). The maturation process is a stepwise increase in the maximum acceptable permeate flow rate depending on the mixed liquor suspended solids (MLSS) concentration and the stepwise increase in the number of membrane tanks brought on-line.

Full process maturation and biology stabilization can take up to 6 weeks.

The maturation period can be reduced and the ADF achieved within a shorter timeframe by:

- Sourcing seed sludge with higher MLSS concentration (concentrate up at source).
- Sourcing fresh and suitable seed sludge.
- Increasing the volume of seed sludge used to commission the process:
- Multiple MBR tanks can be commissioned (if applicable).
- Seed sludge can be concentrated in the MBR tank by batch fill and permeation of the sludge.
- Additional seed sludge can be used during the maturation period.
- Ensuring there is sufficient organic and nutrient load to the plant to quickly build-up the MLSS concentration.

3.07 STRESS TESTING **<u>(Kubota Technician on site 3 trips and 15 days)</u>**

A. A Stress Test shall be conducted following the System Commissioning and maturation period to demonstrate the ability of the MBR System to meet specification requirements for Annual Average Flow, Maximum Month Flow and Peak Daily Flow as described in Table 2–1. MBT system shall also be stress tested at design flux rate and design solids concentration to verify performance.

B. The Supplier shall be responsible for performing the test and shall coordinate as necessary with the General Contractor staff.

C. A certified representative of the Supplier shall be onsite as reasonably required for the testing.

D. Testing shall not commence until the MBR System is operational and the biological process fully stabilized as indicated by the following:

1. Mixed liquor suspended solids concentrations in the reactor shall be greater than 8,000 mg/L but less than 13,000 mg/L.
2. No excessive foaming indicative of upset conditions.
3. Filterability in excess of 10 mL in 5 minutes.

E. All reactors shall undergo testing per Table 3–2. Conditions shall simulate rated Annual Average, MMF, PDF and PHF per Table 2–1 for the plant. During testing:

1. Membrane cleaning, as required, shall be performed after each phase of testing outlined in table 3–2 below.
2. Instantaneous flux, trans–membrane pressure, permeability, temperature and airflow shall be recorded at one-minute intervals.

Table 3-2: Testing Conditions for MBR System				
Testing	**Duration**	**# MBR**	**# SMU**	**Air Scour Rate (SCFM)**
Annual Average	30 days	All	All	Supplier to provide
Max Month	1 week	All	All	Supplier to provide
Peak Daily Flow (PDF)	24 hrs.	All	All	Supplier to provide
Peak Hourly Flow (PHF) [1]	24 hours	All	All	Supplier to provide

[1]- Max flow to MBR will be equalized to 8.0 MGD (5,600 gpm) through Equalization pump station

Note: *MBT system shall be tested separately to insure membranes can meet required WAS thickness with systems provided.*

3. The net (average) output during testing must be within 5% of target MMF and PDF to be considered successful.
4. Failure to pass the Stress Test shall result in an evaluation and retest of the system. A second failure shall require a remedy at the expense of the Supplier up to and including the installation of additional membrane equipment at no additional cost to the Owner.
5. Testing of the MBR membrane at the flux rate of 17.2 gpd/sf

Common issues encountered during I & C testing:

- Inaccurate or incomplete wiring of electrical systems.
- Improperly labeled wires.
- Incorrectly wired 24VDC circuits (reversed polarity).
- Wires loose in the terminal strip.
- Incorrectly wired valve actuators.
- 24VDC wire in the same conduit as higher voltage circuits.
- Reverse rotation of 3 phase equipment.
- Airflow meters are tightened onto their fittings without being properly positioned. These are compression fittings and once the ferrule has compressed the shaft of the meter they cannot be repositioned. Please install these units finger tight only.
- Grounding rings are not installed on mag-tube flow meters.
- Instrumentation installed with the visual display facing the wrong direction. Most displays are adjustable; please review the O&M for specific directions.

Common Wet Testing Issues

- Permeate piping leaks.
- MBR tank wall leaking.
- Permeate pump suction leaks.
- Foaming can occur during clean water phase.
- Reverse motor rotation.

Common Seeding Problems

- Failure to define a realistic seeding plan in advance of startup.
- Failure to plan for the issues noted previously.
- Insufficient volume of quality sludge readily available.
- Under estimation of volume and hauling cost of seed sludge.
- Difficulty introducing seed sludge through fine screens.
- Foaming can occur during seeding and early in the start-up process.
- Insufficient growth yield and process inconsistencies due to low influent biological loading or inaccurate influent load estimations.

3.08 TRAINING (Kubota Technician on site 2 trips and 10 days)

A. The MBR System Supplier shall provide Training in the maintenance and operation of all systems included in the Supplier's control system.

B. Training shall be completed prior to the completion of the System Commissioning. All training shall be performed by the Supplier or a factory–certified representative of the supplier or component supplier. Training is to include:

1. Navigation of all HMI screens and menus.
2. Review of automatic operations and controls.
3. Changing process set points
4. Overriding controls from the HMI
5. Manual operation of the system in the event of a power failure
6. Maintenance cleaning
7. Trouble shooting.

3.09 PROJECT SCHEDULE

A. The MBR System Supplier shall provide the Scope of Supply and associated services specified in this specification in accordance with the Table 3–1.

B. Firm dates for Deliverables as listed in Table 3–3 will be established by Engineer, Contractor, and Customer upon initiation of the project.

Table 3–3: Project Schedule

Deliverable	Due Date
Submittal Documentation	Ten (10) weeks after fully executed notice to proceed from the GC
Installation Documentation (IOM)	Two to Four (2–4) weeks prior to Equipment Delivery at Site
Equipment Delivery at Site	Twenty (20) weeks after receipt of Approved Submittals
Mechanical Inspection	Two (2) weeks prior to System Commissioning
System Commissioning	To be scheduled upon successful completion of Mechanical Inspection

Training	Training to be provided at the conclusion of the System Commissioning
Plant Operations Manual (POM)	Two to Four (4) weeks before completion of System Commissioning

3.10 SUPPLIER SERVICES

A. In addition to the time necessary to complete the requirements established within this specification and elsewhere within the Contract Documents, the MBR System Supplier shall provide up to 54 person–days and minimum 13 on–site visits in support of the Services shown in Tables 3–4 and 3–5 or as needed to commission the plant process to successful results.

Table 3–4: MBR Design Services

Item	Service	Person Days	Estimated Trips	Notes
1	Design Meetings	NA	NA	Meetings to be at Engineer's facility
2	Weekly Status Conference Calls	NA	NA	For duration of the design scope

Table 3–5: MBR Project Execution Services

Item	Service	Person Days	Estimated Trips	Notes
1	Material Inspection During Delivery	4	2	Supplier to verify completed shipment of material at unload
2	Mechanical Inspection	5	2	Supplier to verify Correct Installation
3	Commissioning	15	3	Inclusive of clean water testing and seeding support/startup
4	Stress Testing	15	3	Meeting Parameters
5	Training	10	2	Training during Commissioning
6	Follow -Up @ 6 Month	5	1	Tune-up Controls

B. Time spent remedying equipment deficiencies/problems shall not count toward the listed durations and trips.

C. MBR System Supplier shall be given a minimum of two-week notice prior to the scheduling of any of the listed Services.

D. All service shall be provided by a factory representative or certified subcontractor.

END OF SECTION 45 50 00

INDEX TO

SECTION 46 23 66

GRIT REMOVAL SYSTEM

Paragraph	Title	Page

PART 1 – GENERAL

PART 2 – PRODUCTS

PART 3 – EXECUTION

SECTION 46 23 66

GRIT RREMOVAL SYSTEM

PART 1 – GENERAL

1.01 SCOPE

A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation of the grit removal system as shown on the drawings and specified herein. The manufacturer shall supply the equipment and the general contractor shall install the equipment.

1.02 DESIGN REQUIREMENTS

A. The Grit Removal, Washing, and Dewatering System shall:
   1. Removal efficiency, as outlined in each components section below, shall be based on the following gradation:

% Passing Cumulative									
Micron	75	106	150	212	300	425	600	1000	
Georgia	1.0	5.1	17.8	39.8	60.1	70.8	81.4	94.3	Physical Average
Georgia	0.8	6.7	32.2	56.6	85.6	93.5	97.5	100	SES Average

B. The Grit Removal System shall be comprised of the following components:

   1. Eutek HeadCell® Grit Concentrator
   2. Control Panel

C. The Grit Concentrator unit shall be placed in a concrete tank and receive the incoming screened flow. The Grit Concentrator shall provide sufficient surface area to remove the specified grit particles from the specified peak flow and concentrate the grit in a sump at the bottom of the unit. The de–gritted effluent from the Grit Concentrator shall be weir discharged as shown on the drawings.

D. The Grit Concentrator shall be all–hydraulic, self–activating and shall not require internal moving parts.

E. The Grit Pump shall convey the concentrated grit slurry from the underflow of the Grit Concentrator to the Grit Washing / Classification unit.

F. The system to be furnished hereunder shall be made by a manufacturer regularly engaged in such work and who has furnished similar installations and had them in successful and continuous operation for a minimum period of ten years.

G. Data on performance testing, service history and operation of existing installations using the submitted equipment shall be made available to the Engineer, upon request, for use in determining that the Grit Removal components offered meets the intent of the contract, performance requirements and criteria stated in these specifications.

H. The Grit Concentrator technology shall be designed utilizing Computational Fluid Dynamics (CFD) and field data to verify its flow regime, head loss and grit removal characteristics. Upon request, data on the computation methods used and generic simulation results shall be made available to the engineer.

I. Units using a piped upflow influent distribution design to feed the grit concentrator shall not be accepted.

J. Designs with hydraulic turns greater than 45 degrees shall not be allowed.

K. Multiple flexible connections to the trays shall not be allowed.

L. Units using Apex valves shall not be accepted.

M. Equipment using paddles or air to supplement or induce a vortex shall not be accepted.

1.03 SUBMITTALS AND OPERATION AND MAINTENANCE MANUALS

A. Submittals shall be provided in accordance with the General Conditions and shall include the following:

1. Manufacturer's catalog data and descriptive literature including equipment weights and performance data.
2. General arrangement and dimensional drawings of the grit removal system.
3. Written recommended procedures for job site storage, handling, and installation of the equipment.
4. Hydro International's Intellectual Property licensing agreement.

B. Operation and maintenance manuals shall be provided at the completion of the job and in accordance with the General Conditions. The manuals shall include the following data:

1. Alignment, adjustment, and repair instructions.
2. MANUFACTURER'S installation instructions.
3. Assembly diagrams.
4. Troubleshooting guide.
5. Lubrication instructions.
6. Recommended spare parts lists and predicted life of parts subjected to wear.

1.04 QUALITY ASSURANCE

A. Warranty

1. Any product that proves defective in material, workmanship or design within twelve (12) months after final acceptance shall be, at the discretion

of the MANUFACTURER, modified, repaired or replaced, or Buyer's payment for the products shall be refunded. This shall be Buyer's sole remedy.

B. Certificate of Compliance

1. The MANUFACTURER shall warrant that the Grit Removal System to be supplied shall be manufactured in strict compliance with the Contract Specifications.
2. The Manufacturer representative shall inspect and certified that the equipment is installed according to the manufacturer installation prior to start-up.

C. The system shall be furnished by a MANUFACTURER who is ISO 9001:2008 Certified.

D. MANUFACTURER shall be successful in the experience of manufacture, operation, and servicing of Grit Removal Systems of type, size, quality, performance, and reliability equal to that specified for a period of not less than ten (10) years. The MANUFACTURER shall submit evidence of experience having supplied a minimum of ten (10) installations in North America of similar size to the proposed system and with a maximum surface loading of 11.8 gpm/square foot or less at the specified peak design flow.

E. In the absence of verifiable experience, the MANUFACTURER shall be required to provide an extended warranty and subsequent Performance Bond for the same number of years that the MANUFACTURER was found lacking in experience from the specified ten (10) year period. The performance bond shall commence with acceptance of the equipment and time described herein and beyond the standard warranty period.

F. If equipment other than that shown on the Drawings is submitted to the Engineer for consideration as an equal, it shall be the responsibility of the MANUFACTURER requesting approval to submit with the request a revised design and layout of the mechanical equipment acceptable to the ENGINEER. Revised drawings shall show the proposed location of the alternate unit, and area required for withdrawal space of replacement or serviceable components. This drawing shall also show clearances of adjacent equipment and service area required by that equipment.

Changes in architectural, structural, electrical, mechanical and plumbing requirements for the alternate shall be the responsibility of the Manufacturer requesting approval. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the MANUFACTURER and not the OWNER.

G. Seller shall warrant its products against infringement upon, or violation of, any patent, copyright, trade secret, or any other proprietary right of any third party. In the event of a claim by any third party against the Owner, the Owner shall promptly notify the Seller. The Seller shall then defend such claim, in the Owner's name, but at Seller's expense, and shall indemnify the Owner against any loss, cost, expense or liability arising out of such claim whether or not such claim is successful.

H. *(OPTIONAL) Approved equal MANUFACTURERS shall furnish performance test* *results by an independent party documenting that the System has achieved the specified performance requirement in a minimum of three installations. MANUFACTURERS that are approved as equal are not excused from providing the specified products as outlined below.*

1.05 MANUFACTURER

A. The entire Grit Removal System shall be manufactured by Hydro International, Hillsboro, OR. 2925 NE Aloclek Drive #140, Hillsboro, Oregon, 97124, telephone 503–615–8130. Being named or bidding as an equal does not relieve the manufacturer of meeting these specifications.

B. Alternate manufacturers shall require the engineer's written approval 30 days prior to bid opening.

PART 2. PRODUCTS

2.01 GRIT CONCENTRATOR

A. Design Data

1. Number of Units: 1
2. Size: 12' diameter
3. Number of Trays per Unit: 11
4. Surface Area/Unit: 1243 ft^2
5. Peak Loading Rate:11.2 gpm/ft^2
6. Performance: 95% removal of all grit (specific gravity 2.65) ≥ 75 microns at average flow
7. Performance: 95% removal of all grit (specific gravity 2.65) ≥ 106 microns at peak flow
8. Average Flow/Unit: 8 mgd with no more than 2" headloss
9. Peak Flow/Unit: 20 mgd with 12" headloss
10. Influent Duct Opening: 5'-10"H x at least 3' W
11. Discharge: Weir
12. Underflow Connection: 4"
13. NPW Connection: 1" NPT
14. Materials of Construction: 304 SS Support structure/duct/underflow; PE trays

B. Operation

1. Flow shall transition from the inlet channel or pipe to the trays via an inlet duct positioned above the trays. Each tray shall be connected to the inlet duct by a horizontal nozzle with a rectangular cross section and large clear openings. Round nozzles which reduce cross sectional area shall not

be allowed. Designs with hydraulic turns greater than 45 degrees shall not be allowed.

2. The Grit Concentrator shall have a maximum surface loading rate of 11.8 gpm/square foot to ensure adequate surface area for settling and specified particle removal efficiency. No exceptions shall be allowed.
3. The Grit Concentrator shall be characterized by a controlled boundary layer flow to enhance settleable solids concentration and removal.
4. The Grit Concentrator shall be all–hydraulic consisting of self–cleaning corrosion resistant, non–metallic trays with no moving parts within the unit.
5. All flow passages shall be self–cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.
6. Water shall be continuously supplied to the solids underflow sump.

C. Construction

1. The inlet flume shall be constructed of Minimum 14 gauge formed stainless steel sheet with minimum 3" clear openings. Multiple flexible connections to the trays shall not be allowed. Units using a piped upflow influent distribution design shall not be accepted. Designs with hydraulic turns greater than 45 degrees shall not be allowed.
2. Grit Concentrator trays shall be molded thermoplastic with a minimum ¼ inch thick LDPE on the pans and sidewalls. Formed and welded stainless steel trays shall not be allowed.
3. The stack of trays shall securely fit into a stainless–steel support frame. The support frame shall fit and secure to the bottom of the CONTRACTOR supplied concrete support structure.
4. A stainless–steel grit collector shall be provided with the Grit Concentrator for collection and removal of settled solids to the respective Grit Separation / Classification /Washing unit. The grit collector shall be installed in the CONTRACTOR supplied concrete tank and incorporate the flanged underflow and threaded fluidizing pipe connections.
5. All pipe flanges shall conform to ANSI B16.1 bolt pattern.

D. Valves and Accessories

1. The Grit Concentrator shall be provided with the following accessories:
   a) One (1) 1" bronze globe valve to regulate the system water flow rate to the grit collector.
   b) One (1) 1" bronze ball valve for shut off
   c) One (1) 8–40_gpm acrylic flow meter
2. Unions or quick disconnects are to be incorporated into the piping on either side of the flow meter for ease of removal and cleaning. The quick disconnects or couplings are to be supplied and installed by the contractor.

2.02 GRIT PUMP (SEE SPEC SECTION 46 23 67)

2.03 CONTROLS AND INSTRUMENTATION

A. Control Panel

1. One (1) control panel shall be furnished, completely pre–wired and tested.

2. The control panel shall adhere to the following specifications:

a)	Enclosure Rating:	NEMA 4X
b)	Material:	316SS
c)	Voltage:	460 Volt
d)	Phase:	3 Phase
e)	Frequency:	60 Hz
f)	Load:	TBD Amp
g)	Logic:	Programmable Relay

3. The Control panel shall contain all timers, VFDs, switches, indicator lights, and other components necessary to operate the following equipment:
   a) One (1) Grit Pump
   b) One (1) Grit Classification unit

4. The control panel shall be supplied with a Transformer with 480-volt primary winding and 120-volt secondary winding with fused secondary.

5. The control panel shall be supplied with applicable control relays and time delay relays with a minimum one extra normally closed and one extra normally opened contact is provided for each relay. The control panel shall also control solenoid reuse water valve.

6. Where remote monitoring is required, the panel shall be provided with all dry contacts necessary.

7. The panel door layout shall include the following items:
   a) Front panel mounted combination main disconnect switch and circuit breaker
   b) Back lit, push–to–test Power On indicating light
   c) System three position HOA switch
   d) System Emergency Stop push button
   e) System Alarm Reset push button (optional)
   f) Grit Pump running light
   g) Grit Pump three position HOA switch
   h) Grit Pump fail indicating light
   i) Grit Pump manual START push button
   j) Grit Pump manual STOP push button
   k) Grit Pump manual speed potentiometer
   l) Grit Separation / Classification three position HOA switch

m) Grit Separation / Classification utility water three position HOA switch.

n) Grit Separation / Classification backwash water valve three position HOA switch

o) Grit Separation / Classification auxiliary backwash pushbutton

p) Grit Separation / Classification RUNNING indicating light

q) Grit Separation / Classification supply valve OPEN light

r) Grit Separation / Classification backwash valve OPEN light

s) Grit Separation / Classification WET/DRY/REMOTE three position switch

2.04 SEQUENCE OF OPERATION

1. The system shall be controlled manually operation, manual starting and stopping, and system shut down when a fault is detected.

2. Clarified plant water shall be supplied and distributed between the Grit Concentrator fluidizing line, the Grit Washing / Classification unit.

3. Screened raw wastewater shall be gravity fed into the Grit Concentrator continuously.

4. Grit Washing / Classification unit

   a) Grit slurry from the Grit Concentrator shall be pumped to the Grit Washing / Classification continuously.

5. Grit Classifier unit

   a) The Grit Dewatering and Classification unit shall run In CONTINUOUS mode. In INTERMITTENT operations the screw will run off and on using adjustable timers. When the screw stops, the water solenoid valve closes with a default run time of 5 minutes. The default stop time is 15 minutes. The Hydrogritter Screw Classifier requires a continuous 5 gpm @ 40 +/- 10 psig of clarified "reuse water".

   b) While the dewatering unit is running, water shall be directed to the sluice of the classifier unit.

   c) After a System Shut Down the Grit Dewatering Classifier shall continue to operate for a pre–determined amount of time to allow for the removal and dewatering of all grit accumulated in the clarifier. The off–delay timer shall be adjustable from 0–60 minutes with a typically delay off time of 15 minutes.

2.05 UTILITY REQUIREMENTS

A. WATER

   1. The Grit Concentrator Unit shall require a minimum supply of 20 gpm clarified non–potable water at a minimum 50 psig.

B. ELECTRICAL

   1. The system shall require one (1) 480 VAC, three phase electrical service connection to operate

2.06 MATERIALS AND FINISHES

A. MATERIALS

1. All stainless steel used for the fabrication of the equipment shall conform to the following standards:

Plate and Sheet	ASTM A 167
	ASTM A 240
Bar	ASTM A 276
	ASTM A 479
Tube	ASTM A 312

B. EXTERIOR SURFACES FINISHES

1. All surfaces shall be free of sharp edges, weld spatter and residue. All welds shall be ground smooth.
2. All stainless–steel surfaces shall be acid washed.
3. All non–submerged exterior surfaces shall be Glass Bead Blasted to a uniform finish.

PART 3. EXECUTION

3.01 DELIVERY AND INSTALLATION

A. The equipment and material shall be shipped complete except where partial disassembly is required by transportation regulations or for protection of components.

B. Spare parts shall be packed in containers bearing packing lists clearly designating contents and pieces of equipment for which they are intended.

C. The CONTRACTOR shall inspect equipment prior to unloading and notify the MANUFACTURER of any damage to equipment within 5 days to effect proper remedial action. Failure to notify the MANUFACTURER of damage to equipment prior to unloading shall void all warranties pertaining to subject equipment.

D. The CONTRACTOR shall unload, store and safeguard equipment, materials, and spare parts in accordance with MANUFACTURER'S recommendations.

3.02 START–UP, TRAINING AND MANUFACTURER'S SERVICES

A. A factory trained representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for a maximum of four (4) 8–hour man–days (two (2) visits) for installation inspection, plant startup, functional testing, and operator instructions; travel time excluded. A minimum of 30 days notice is required to schedule manufacturer's services. Any services with less than 30 days notice shall be billed for service time and actual travel costs.

3.03 FUNCTIONAL TESTING

A. Prior to plant startup, all equipment shall be inspected for proper alignment, operation, connection, and satisfactory operation by means of a functional test. It is the General Contractor's responsibility to duly notify the MANUFACTURER of any inabilities to perform functional testing prior to operator training.

3.04 MANUFACTURER'S CERTIFICATE(S)

A. Provide MANUFACTURER'S certificate of installation and commissioning following functional testing and startup.

B. Provide MANUFACTURER'S OEM Software Licensing Agreement following acceptance and final payment.

END OF SECTION 46 23 66

INDEX TO

SECTION 46 23 67

GRIT REMOVAL PUMP

SECTION 46 23 67

GRIT RREMOVAL PUMP

PART 1 GENERAL

1.01 Description

There shall be supplied as shown by the plans one (1) horizontal vortex–type slurry pumping units specifically designed to pump slurries of grit, debris and organic solids without clogging.

1.02 QUALITY ASSURANCE

A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein.

B. To insure a consistent high standard of quality, the manufacturer of this pumping equipment shall comply with the requirements of the ISO 9001 Quality and ISO 14001 Environmental Management Systems, and such compliance shall be verified by an independent certification agency approved by the International Organization for Standardization. Documentation shall be submitted for approval showing compliance with this requirement, and the equipment will not be released for shipment until approved.

C. Unit responsibility. Pumps, complete with motor, V–belt, baseplate, necessary guards, and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to insure compatibility and integrity of the individual components and provide the specified warranty for all components.

D. The vortex–type pumps specified in this section shall be furnished by and be the product of one manufacturer.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 0133 00.

B. Submit manufacturer's installation instructions, and inspection under provisions of Section 01 45 23.

C. The submittal data shall be prepared, in its entirety, by the equipment manufacturer. Shop drawings prepared by the manufacturer's sales representative, fabrication shop or other than the listed manufacturers shall not be acceptable. No additions or modifications to the manufacturer's submittal will be accepted, with the sole exception of a cover sheet provided by the manufacturer's local representative.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 78 23.

B. Include installation instructions, assembly views, lubrication instructions, and replacement parts lists.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect under provisions of Section 01 65 00.

1.06 SERVICES OF MANUFACTURER

A. Furnish the services of a representative of the pump manufacturer to assist in adjusting and testing the equipment furnished, to supervise the initial operation, and to make final adjustments as may be necessary to assure the OWNER that the pumps is are in satisfactory operating condition.

B. Furnish sufficient supervision, data, and information from the manufacturer to train operators in the proper operation and maintenance of the pumps furnished.

PART 2 PRODUCTS

2.01 PUMPS

A. PERFORMANCE

1. The pumps shall be designed for continuous operation and will be operated continuously under normal service.

B. OPERATION CRITERIA

	Flow GPM	**TDH FT**	**Max. Pump RPM**	**Solids Passage**	**Min. Suction Dia.**	**Min. Disch. Dia.**	**Min. Motor Size**
Primary Design Condition	300	**15**	900	4	4	4	10
Secondary Design Condition	400	**12**	900	4	4	4	10

C. DESIGN

1. Since these pumps will be used to pump abrasive grit and other solids, the pumps shall be specifically designed to both optimize wear resistance and then maintain hydraulic performance as wear occurs.

2. The pumps shall be of a fully recessed, Slurry Type design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connection, so that solids are not required to flow through the impeller. All flow path clearances within the pumps shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.

3. The impeller shall be constructed of 650 Brinell Ni–Hard or Hi–Chrome Iron and specifically designed to maintain hydraulic pumping performance as wear occurs.

   a. The impeller shall be of cup design such that the deepest portion of the vane is not located at the vane tips and the tips are surrounded by a thick–sectioned rim of the following thickness:

Pump Size	Minimum Impeller Dia. @ Outside Rim	Minimum Rim Thickness @ Wear Area	Minimum Vane Thickness @ Wear Area	Impeller Minimum Ni–Hard or Hi–Chrome Iron Weight
4 In.	**16 In.**	**1–5/8 In.**	**7/8 In.**	**90 Lbs.**

   b. The hydraulic design shall be such that the length of the impeller vane increases as wear occurs to the rim, allowing as–new or better pumping performance throughout the wear cycle of the impeller.

   c. The hydraulic design of the impeller shall preferentially direct flow to a sacrificial, independently replaceable suction piece. The suction piece shall be easily accessible and replaceable, without the need to disassemble any other component of the pump.

   d. Pump–out vanes on the rear shroud of the impeller are not acceptable. Impellers of the radial design that incorporate the impeller in a recessed portion of the volute or wearplate are not acceptable.

4. A removable wearplate of Ni–Hard or Hi–Chrome Iron shall be provided behind the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing.

5. The packing housing shall be a separate piece bolted to the bearing housing for ease of removal. Designs that incorporate the stuffing box as an integral part of the wear plate and/or backplate assembly are not acceptable.

6. The pump casing shall be of the two–piece radially split type, with a separate and removable suction piece designed so that the impeller can be withdrawn without the need to remove the discharge casing or disturb the discharge piping. The casing shall be constructed so that it can be reversed for opposite rotation and shall be of Ni–Hard or Hi–Chrome Iron. To insure a liberal wear allowance, the casing and suction piece shall be constructed, and the entire wet end weights shall be, as follows:

Discharge Diameter	Casing Minimum	Suction Piece at Wear Area	Weight* of Wearing Parts
4 In.	**3/4 In.**	**1–1/4 In.**	**500 lbs.**

*Suction piece, impeller, casing, and wear plate.

7. The pump's head vs. capacity curve shall slope upward toward shutoff in one continuous curve with no points of inflection capable of causing hunting at any pump operational speed.

8. Pumps shall be equipped with slotted raised–face flanges to receive 125 lb. standard bolting. Special case slots shall be cast in to retain bolts and to fasten the case to the bearing housing and to the intake for easy case removal.

D. MATERIALS OF CONSTRUCTION

1. The parts exposed to abrasive wear – case, removable suction piece, impeller, and wearplate shall be of all Ni–Hard or Hi–Chrome Iron material conforming to ASTM Designation A532–75 Class I or Class III, Type A, and be a minimum of 650 Brinell hardness for maximum wear resistance. Brinell values below this are not acceptable.

2. Test bars shall be cast integrally with the case and suction piece and shall remain attached to the casting upon final delivery to the owner. Test bars shall be of sufficient thickness to represent the average thickness of the cast part. After receipt of final delivery, the owner may at any time prior to the final acceptance, remove the test bar and independently verify compliance to the material and hardness specification. Failure of the tested bars to meet the specified requirements shall be cause for rejection.

E. BEARING HOUSING

1. The bearing housing shall be of cast iron, ASTM A48CL–25.

2. The shaft shall be of ASTM A108, Grade 1045 (or equal) steel, and shall be protected by a removable, hardened Type 410, 416 or 420 stainless steel shaft sleeves.

3. Bearings shall be oil bath lubricated. The oil reservoir shall be sealed at both ends to prevent entrance of foreign matter. The thrust bearings shall consist of three angular contact ball bearings for maximum protection from all thrust loads. The bearing housing will be equipped with a pressure venting device and oil fill and drain taps. A built–in sight glass shall be furnished to check proper oil level. The bearings shall be rated for a minimum B10 life of 100,000 hours, without credit for any rear pump–out vanes to balance hydraulic thrust.

F. SHAFT SEALING

1. <u>Mechanical Seal</u>

a. A single cartridge mechanical seal requiring no external flushing shall be furnished in the pump. The seal shall utilize a rotational sealing ring mounted in an elastomer cup with an o–ring mounted stationary ring loaded by a non–fouling, conical spring encapsulated in Viton. Installation of the seal shall require no measurements or scribe marks on the shaft.

b. The rotational sealing ring shall be made of tungsten carbide Grade VC 805, the surface of which shall be lapped to a flatness not to exceed three helium light bands. The sealing ring shall be bonded inside a Viton rubber cup, which shall have three (3) integrally molded anti–rotational lugs to prevent the rotary seal face from turning within the rotary body. Additionally, the rotary body shall have three (3) 1/8" solid stainless–steel pins to also prevent the rotary seal face from turning within the rotary body.

c. The stationary sealing ring shall be also be constructed of tungsten carbide Grade VC 805. The surface shall be lapped to a flatness not to exceed three helium light bands. The stationary ring shall have a slot milled on the side opposite of the mating side, which engages an anti–rotation pin. Stationary sealing rings of converted carbon or other surface–only treatments are not acceptable.

d. The spring that loads the rotational sealing ring shall be cone–type, non–fouling design and shall run in the pumped product without fouling or hang–up. The spring metal material shall be SAE1095 Carbon Steel, ASTM A–682 heat–treated to a Rockwell C hardness of 45 to 50 and be totally encapsulated in Viton for protection from the pumped fluid. The product side of the spring shall have a minimum 1/4" thick Viton rubber covering for corrosion/abrasion protection. Seals which use single coil, multiple coil, bellows and rubber–in–shear designs are not acceptable.

e. To minimize the number of points where the slurry must be sealed, the mechanical seal assembly shall have no more than three (3) o–rings: one (1) shaft sleeve o–ring, one (1) stationary face o–ring, and one (1) retainer o–ring. O–rings are to be made of Viton. Seals using more than three (3) o–rings are not acceptable.

f. All metal components not encapsulated in Viton shall be constructed of abrasion–resistant CD4MCu ASTM A–743. Surface finish shall be a maximum of 64 RMS.

g. The seal shall be capable of running with up to ± 0.025" radial shaft deflection and ± 0.040" axial shaft deflection without leakage, damage, or loss of performance.

h. A seal chamber of Hi–chrome iron, ASTM A–532, minimum 600 Brinell, shall be provided to mount the seal and to provide a reservoir of adequate volume for the pumped product to contact and to lubricate the seal faces. The seal shall be installed into the seal chamber from the impeller side of the pump so that only the casing/suction piece and impeller need to be removed to gain complete access to the seal for inspection and/or maintenance.

i. Seals requiring a water or product flush may be furnished in lieu of the non–flushed seal, provided the contractor furnishes, at no extra charge, all of the external auxiliary equipment necessary for the flushing system, including, but not limited to:

1) Isolated water/flush supply system to the seal, including pump, reservoir, pressure reduction valve, solenoid valve, bypass piping and check valve, all furnished in a suitable enclosure, associated wiring, and modifications to the motor control center to actuate the solenoid valve.

2) A pressure gauge, flowmeter, shutoff and isolation valves, manual throttle valve, and strainer at the pump.

3) All tubing/piping shall be stainless steel.

G. MOUNTING

1. Belt Drive

a. The pump manufacturer shall provide a common pump and motor base, constructed of a minimum 3/8–inch–thick fabricated steel, suitably reinforced to support the full weight of the pump, motor, belt drive and guards.

b. The pump manufacturer shall furnish and install a separate, adjustable motor base with handwheel adjustment so that the motor can be easily moved for V–belt tensioning and adjustment, TB Woods type MC 3B, modified with a welded steel gusset, or equal.

c. The pump manufacturer shall supply and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions.

d. The drive shall be of the stationary control variable speed TB Woods type 'SVS' or equal, which allows a speed change by means of an adjustment to the motor sheave when the drive is not in operation.

e. An approved fiberglass or thermoplastic belt guard shall be provided to safely enclose the belt drive. If metal guards are furnished, they shall be of all 316–stainless steel construction with suitable lifting eyes and handles to aid in removal.

H. MOTOR

1. Motor shall be horizontal, TEFC type, 10 HP, 3 Phase, 60 Cycle, 460 Volt, 1760 RPM, and shall be connected to the pump by the drive method specified. All motors shall be of nationally known manufacture and shall conform to NEMA standards and specifications.

2. Performance Testing

a. A certified shop test shall be performed on each pumping unit in accordance with the test code of the Hydraulic Institute protocol "A". Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency for capacity from shutoff to 150% of design flow. A minimum of five points, including shutoff, shall be taken for each test run. At least one point of the five shall be taken as near as possible to each specified condition.

b. Results of the performance tests shall be certified by a Registered Professional Engineer and submitted for approval before final shipment.

c. A representative of the owner shall witness the certified test.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the pumps in accordance with the manufacturer's instructions.

B. Lubricate the equipment before start–up.

C. Conduct Field Tests to demonstrate that the pump(s) perform in accordance with the specifications.

D. One trip of two (2) days shall be provided for the services of a factory technician for start–up and O&M instruction to the Owner's personnel.

INDEX TO

SECTION 46 23 67.1 – Grit Classifier

Section 46 23 67.1

Grit Classifier

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Furnish and install one (1) degritting system(s), consisting of one (1) 12-inch minimum diameter screw-type dewatering classifier, complete with one (1) 10-inch minimum diameter grit cyclone per classifier.

1.2 QUALITY ASSURANCE

A. All degritting equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications and it shall be demonstrated to the satisfaction of the Owner that the quality is equal to equipment made by that manufacturer specifically named herein. Manufacturers shall provide evidence of at least five (5) installations in which identically sized equipment has provided satisfactory performance for a minimum of five (5) years in a similar application. No consideration will be given to individually sized equipment that has not been commercially available for at least five (5) years.

B. To insure a consistently high standard of quality, the manufacturer of this pumping equipment shall comply with the requirements of the ISO 9001 Quality System, and such compliance shall be verified by an independent certification agency approved by the International Organization for Standardization. Documentation shall be submitted for approval showing compliance with this requirement, and the equipment will not be released for shipment until approved.

C. The complete degritting system specified in this section shall be furnished by, and be the product of, one manufacturer including the grit pump, cyclone, classifier and all specified accessories and appurtenances, to ensure compatibility, integrity of individual components and unit responsibility.

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00.

B. Submit manufacturer's installation, start-up instructions under provisions of Section 01 75 15.

C. The submittal data shall be prepared, in its entirety, by the equipment manufacturer. Shop drawings prepared by the manufacturer's sales representative, fabrication shops, or other than the listed manufacturers will not be acceptable. No additions or modifications to the manufacturer's submittal will be accepted, with the sole exception of a cover sheet provided by the manufacturer's local Representative.

D. The classifier and cyclone operating parameters, i.e., cyclone feed rate, pressure and underflow and classifier pool area, weir length, screw speed, submergence, and slope, have been selected to avoid build-up of fine grit in the classifier tank, which will cause grit of the desired size to be lost. Changes in any of these parameters will not be acceptable unless a detailed submittal showing calculations and operating data provides evidence that any such change will not affect the ability of the system to perform as specified.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 78 15.

B. Include installation instructions, assembly views, lubrication instructions, and replacement parts lists.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, handle and protect the equipment under provisions of Section 01 65 00.

1.6 SERVICES OF MANUFACTURER

A. Furnish the services of a representative of the degritting system manufacturer to assist in adjusting and mechanical testing of the equipment furnished, to supervise the initial operation, and to make final adjustments as may be necessary to assure the Owner that the degritting system is in satisfactory operating condition.

B. Furnish sufficient supervision, data, and information from the manufacturer to train operators in the proper operation and maintenance of the equipment furnished.

1.7 CONDITIONS OF SERVICE AND PERFORMANCE

A. Grit collector underflow shall be pumped to the grit cyclone(s). The cyclone(s) shall separate inlet feed into two streams: overflow and underflow. The overflow shall include the majority of the liquid along with lighter organic materials. The underflow shall be concentrated grit slurry which shall be directed into the grit classifier. The grit classifier shall further remove organic material and shall separate the grit for discharge into a grit disposal system.

B. Each cyclone shall be sized for an inlet feed of 300 - 400 gpm at a pressure of 10 -15 psi. At the inlet feed conditions specified, each grit cyclone shall be capable of removing 95 percent of the grit entering the inlet feed that is larger than 150 mesh and has a specific gravity of 2.65 or greater.

C. At the inlet feed conditions specified, each grit classifier shall be capable of removing 95 percent of 150 mesh and larger grit from the underflow of the cyclone.

PART 2 – PRODUCTS

2.1 CYCLONE

A. Each cyclone shall consist of a heavy-duty cast iron volute feed chamber with one fabricated steel cylindrical section with 2 conical sections and two apex sections of aluminum to minimize overhung weight.

1. Each section of the cyclone shall be individually lined and protected from the high velocity grit by a replaceable rubber or liner. The cyclone shall be constructed so that any section of the liner can be replaced independently.

2. A hinge and quick disconnect clamp shall be provided between the apex assembly and lower cone section to allow removal of material which may clog the apex, without disconnecting any piping on the cyclone itself.

B. The inlet feed to the cyclone shall be 4-inch, the overflow 6-inch, with Victaulic connections furnished by the cyclone manufacturer. Cast iron adaptor pieces will be provided with ANSI 125 lb. flat face flanges. The adaptor piece will be fitted with a cast iron elbow on the overflow so that the flange face will mate up with horizontal piping.

C. Each cyclone shall be supplied complete with a 2-inch apex.

D. The cyclone vortex finder shall be 4-inch diameter and made of Ni-Hard with a minimum hardness of 500 Brinell.

E. Each cyclone inlet feed shall be tapped for a 1" NPT gauge connection and a diaphragm-protected pressure gauge shall be provided by the cyclone manufacturer.

F. The cyclone underflow shall feed into the classifier for washing and dewatering and be sized so that the proper hydraulic loading is provided to the classifier.

G. The cyclone overflow will feed to piping furnished by the contractor which must be properly and adequately vented to prevent siphoning.

H. The cyclone manufacturer shall supply a fabricated 316 stainless steel support to mount the supplied cyclones.

1. The cyclone shall be attached to a minimum 3/8-inch 316 stainless steel mounting plate, properly oriented such that the cyclone underflow discharges directly into the classifier feedbox.

2.2 CLASSIFIER

A. Each classifier shall consist of a full flare fabricated 316 stainless steel grit settling tank with a screw-type grit conveyor.

B. The classifier shall have a minimum pool area at maximum water level of 8.3 square feet, a minimum weir length of 28.3inches, and a screw speed of 12 RPM maximum.

1. The classifier pool depth and weir height shall be adjustable by removable weir bars.

2. The grit settling tank shall be constructed of 1/4" 316 stainless steel plate, suitably reinforced and mounted on 316 stainless steel supports at a slope of not more than 3-1/2 inches per foot. The tank shall be designed to provide a settling compartment where grit separation takes place, with a minimum full water depth of 150% of the screw diameter.

3. The weir overflow shall discharge into a launder box equipped with a screwed pipe nozzle or Victaulic fitting for connection to 2 1/2-inch drain connection.

4. The classifier tank shall be provided with a welded bar, running from the top of the tank to below the water level to provide a sluice channel, in order to prevent the buildup of grit opposite the raked material, to aid in drainage. The manufacturer shall supply and install a valve cock with a 3/8-inch NPT nipple for the spiral sluice water. A 115-volt, single phase solenoid valve, which is compatible with the motor enclosure, shall also be supplied and installed by the manufacturer for the sluice water line and connected by the electrical contractor to open when the Hydrogritter motor is activated.

5. Each classifier tank shall be fitted with a grit discharge opening, located such that

accumulated grit at the top (dry) end of the screw conveyor shall exit the tank in a vertical down direction through the grit discharge opening.

C. Each classifier tank shall be supplied complete with a fabricated feed box to facilitate the introduction of underflow from the cyclone into the classifier.

1. The feed box shall be reinforced minimum 12-gauge 316 stainless steel plate, and shall be fitted with a wear protector, coated with ¼-inch thick neoprene to protect against abrasion, and to function as a splashguard. The wear protector and splashguard shall be internal to the feedbox such that no splashing will be allowed outside the feedbox. Radial flow diffusers shall not be acceptable.

2. The feed boxes shall have hinged covers, to provide for inspection of the cyclone apexes without disturbing the cyclone piping or alignment. The hinged covers shall be provided with two snap buckles, one on each side, for quick release.

3. The feed boxes shall be designed and located by the manufacturer to minimize short-circuiting to the overflow weir of the classifier, and to handle maximum cyclone underflow discharge.

4. The classifier manufacturer shall be responsible for ensuring that the feed boxes are designed to dissipate energy generated from the cyclone underflow, to minimize disruption of the classifier pool.

D. The grit shall be removed from the bottom of the settling compartment and discharged by means of a 50% pitch, 12-inch diameter screw-type conveyor.

1. The screw shall be made from pre-formed heavy 316 stainless steel flight sections welded to the shaft and fitted with replaceable wearing shoes.

a. The screw shaft of the conveyor shall be a minimum of 3-inch diameter, Schedule 80 pipe, and shall be designed with a maximum stress of 3000 psi, and a fatigue at 98% reliability of 20 years minimum. If calculations are required, they shall be signed by a registered Professional Engineer, showing compliance with these requirements and shall be submitted for approval.

b. The flights shall be a minimum thickness of 12-gauge 316 stainless steel, welded to the pipe shaft. The flights shall be a minimum height of 4 inches, as measures along the face of the flight.

c. Wearing shoes shall be abrasion resistant and mounted on the flights by means of flat head screws and nuts. The abrasion resistant wearing shoes shall be made of ARS, and shall be a minimum of 10 gauge in thickness by 4-inches high.

d. The screw shall have the capacity to remove 3/4 tons per hour of grit from the grit settling tank.

e. Shaftless spirals shall not be considered equal and are not acceptable.

E. The screw conveyor shall be rigidly supported at both the upper and lower ends, so that the screw conveyor is mounted above, and does not contact, the classifier tank. This mounting shall provide for a clearance between the screw conveyor and the tank bottom, so that a buildup of sand or grit will provide a bed for the screw, eliminating tank wear, and providing a drainage area for the conveyed grit.

1. The upper end of the screw conveyor shall be connected to a cycloidal motion speed reducer. The cycloidal speed reducer shall be designed so that all torque is transmitted by rollers and shall be capable of withstanding shock loads of 500% of rated loading.

    a. Gear-type speed reducers are not acceptable.

    b. The cyclodrive shall be connected to a 1/2 HP, totally enclosed motor by means of a belt drive and fitted with a guard of the same material as the spiral guard.

2. The lower end of the screw shall be supported by a submerged bearing, housed in a water-tight cast iron housing, suitable for completely submerged operation in grit service.

    a. The bearing shall be designed to accept radial loads from the spiral screw conveyor.

    b. The cast iron housing shall be provided with stainless steel cap screws, and fill and drain plugs.

    c. The bearing shall utilize a sealed bronze sleeve-type bearing, running completely submerged in oil, and shall require only yearly inspection and oil change.

    d. The bearing shall be provided with permanent stellite seals to prevent the leakage of oil and infiltration of grit and other foreign particles into the housing. The seal shall be of the self-compensating type, consisting of two mating hardened steel alloy rings, each held in place by a rubber toric. The wearing surfaces of the rings shall be precision lapped to form an initial sealing band of approximately 1/32 inch in width. The seal shall be designed such that as seal rings wear through normal operation, the pressure from the rubber torics shall push the rings further against each other to form a broadened contact band.

    e. Lower bearing designs incorporating conventional packing, requiring external flushing, or bearings located outside the grit tank will not be acceptable.

F. The complete drive assembly, screw conveyor, and lower bearing assembly shall be designed so that the screw can be raised for inspection without the need to disassemble any components, or to drain the classifier tank.

1. The complete drive assembly shall be pivoted at the shaft centerline so that the screw assembly can be raised for periodic inspection.

2. The lower end of the assembly shall be attached to a manually operated handwheel and screw-type lifting device designed to allow the entire assembly to be lifted above the maximum water level. Cable type lifting systems are not acceptable.

3. The belts and sheaves on the drive assembly shall be covered with a guard of the same material as the combination classifier spiral guard.

G. The classifier shall be fitted with an OSHA approved classifier spiral guard to enclose the entire settling tank during normal operation. The classifier spiral guard shall be designed to prevent objects from coming into contact with moving parts while the classifier is in operation.

1. The classifier spiral guard shall be provided in two pieces for ease of removal and to minimize the weight of any single piece.

2. The cover shall be clamped to the classifier tank, to allow for removal, regular maintenance, and inspection. The clamps shall be designed so that they cannot be removed without the use of tools. Welded on or permanently affixed covers are not acceptable.

3. The cover shall be made of the same material as the tank with expanded metal viewing windows to allow for inspection of the settling pool and upper portion of the spiral.

H. For corrosion-resistance, all non-submerged ferrous metal pieces shall be near white metal blasted to spec SSPC-SP10 before being primed and top coated with a two-part epoxy with a minimum solids content of 58% to a dry film thickness of 3 to 5 mils.

1. All submerged metal pieces shall be coated with a two-part coal tar epoxy with a minimum solids content of 75% to a dry film thickness of 16 to 20 mils.

2. Stainless steel parts shall receive a cosmetic blast with non-ferrous media to remove all weld stain markings and give the surface a uniform appearance. Stainless steel parts will not be coated.

2.3 OPTIONAL EQUIPMENT

A. Classifier safety stop switch: The classifier tank will be fitted with an emergency stop system.

1. The tank will be fitted with a vinyl coated wire rope running the periphery of the classifier tank and connected to the safety stop switch.

2. When the wire rope is pulled, it will actuate the safety stop switch that must be connected by the Contractor in such a way that the classifier motor will immediately shut down.

3. The switch shall be fitted with a single pole double throw micro switch at each end.

4. The switch shall be fitted with a raised flag for positive identification of when the switch has been actuated. The switch shall be reset by raising the flag arms to their original position.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install the degritting system in accordance with the manufacturer's instructions.

B. Lubricate the equipment before start-up.

C. Conduct field tests to demonstrate that the system performs according to the specifications.

D. 3 days over one trip of field service for start-up, testing and O&M instruction shall be provided.

END OF SECTION

DIVISION 26 – ELECTRICAL

260500 – BASIC ELECTRICAL REQUIREMENTS

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 division of the Specifications, Division 26 000, covers the complete interior and exterior electrical systems as indicated on the drawings or as specified herein. Provide all materials, labor, equipment and supervision to install electrical systems.

1.03 QUALITY ASSURANCE

A. All electrical work shall be in accordance with the following codes and agencies:

1. The National Electrical Code (NFPA 70) – 2017 with Georgia Ammendments.
2. The National Electrical Safety Code (ANSI C-2)
3. The Life Safety Code (NFPA 101)
4. The International Building Code
5. Occupation Safety and Health Administration (OSHA)
6. Manufacturer's written requirements.
7. Regulations of the local utility company with respect to metering and service entrance.
8. Municipal and state ordinances governing electrical work.

B. Material Standards: All material shall be new and shall conform to the standards where such have been established for the particular material in question. Publications and Standards of the organization listed below are applicable to materials specified herein.

1. American Society for Testing and Materials (ASTM)
2. Underwriters' Laboratories, Inc. (UL)
3. National Electrical Manufacturer Association (NEMA)
4. Insulated Cable Engineers Association (ICEA)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. National Fire Protection Association (NFPA)
7. American National Standards Institute (ANSI)
8. Manufacturer's Written Requirements

1.04 PERMITS

A. Obtain all permits and inspections for the installation of this work and pay all charges incident thereto. Deliver to the Owner all certificates of said inspection issued by authorities having jurisdiction.

1.05 WARRANTY

A. For warranty of work under Division 16, refer to the GENERAL CONDITIONS.

1.06 DRAWINGS

A. The drawings indicate the arrangements of electrical equipment. Review architectural drawings for door swings, cabinets, counters and built-in equipment; conditions indicated on architectural plans shall govern. Coordinate installation of electrical equipment with structural system and mechanical equipment and access thereto. Coordinate installation of recessed electrical equipment with concealed ductwork and piping, and wall thickness.

B. Do not scale drawings. Obtain dimensions for layout of equipment from Architectural plans unless indicated on Electrical plans.

C. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Engineer.

D. Equipment layout is based on one manufacturer's product. Where equipment selected by the Contractor for use on the job differs from layout, the Contractor shall be responsible for coordinating space requirements and connection arrangements.

1.07 SUBMITTALS:

A. Shop Drawings and Product Data:

1. The Contractor shall submit for review by the Engineer data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, catalogs, cuts, diagrams, performance curves, and charts published by the manufacturer to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Provide complete electrical characteristics for all equipment. Submittals for lighting fixtures shall include Photometric data.
2. Refer to the individual sections for identified equipment and materials for which submittals are required.
3. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES section for required procedures.

B. Record Documents

1. Refer to Division 1 for record documents and related submittals.

1.08 OPERATION AND MAINTENANCE DATA AND INSTRUCTIONS

A. Refer to Division 1 for detail requirements.

B. Printed Material: Provide required printed material for binding in operation and maintenance manuals.

C. Instructions of Owner Personnel:

1. Before final inspection, as designated by the Engineer provide a competent representative to instruct Owner's designated personnel in systems under this division of the specifications.
2. Use operation and maintenance manuals as basis of instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
3. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.09 EQUIPMENT REQUIRING ELECTRICAL SERVICE

A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment requiring electrical service. Refer to ELECTRICAL CONNECTIONS FOR EQUIPMENT section for connection requirements.

B. Drawings indicate design loads and voltages and corresponding control equipment, feeders, and overcurrent devices. If equipment actually furnished have loads other than those indicated on the drawings or specified herein, control equipment, feeders, and overcurrent devices shall be adjusted in size accordingly at no additional cost to the Owner. Such adjustment shall be subject to the review of the Engineer.

C. Incidental items not indicated on Drawings or mentioned in Specifications but that can legitimately and reasonably be inferred to belong to the Work or be necessary in good practice to provide a complete system, shall be furnished and installed as though itemized here in detail. This includes connection requirements for air conditioning and refrigeration equipment as outlined by NEC Article 440.

1.10 SCHEDULING OF OUTAGES

A. Electrical work requiring interruption of electrical power which would adversely affect the normal operation of the other portions of the Owner's property, shall be done at time other than normal working hours. Normal working hours shall be considered eight A.M. to five P.M. Monday through Friday.

B. Schedule all work requiring interruption of electrical power two weeks prior to actual shutdown. Submit schedule in writing indicating extent of system to be de-energized, date and time when power is intended to be interrupted, and date and time power will be restored. Schedule shall be subject to the approval of the Engineer and the Representative of the Owner.

1.11 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project. Where work under this project requires extension, relocation, reconnections or modifications to existing equipment or systems, the existing equipment or systems, shall be restored to their original condition, with the exception of the work under this contract, before the completion of this project.

PART 2- BASIC MATERIALS

2.01 MATERIALS

A. All materials shall be new.

B. Furnish all materials specified herein or indicated on the drawings.

C. Materials of the same type shall be the product of one manufacturer.

D. All materials shall be UL listed and shall bear UL label. ETL listed material shall bear ETL label. ETL label shall be accepted in lieu of UL when the UL testing standards have been followed.

PART 3 - DISTRIBUTION PRODUCTS

3.01 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

A. Inspect materials upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material. Handle materials in accordance with manufacturer's applicable standards and suppliers recommendations, and in a manner to prevent damage to materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Containers which are broken, opened, damaged, or watermarked are unacceptable and shall be removed from the premises.

B. All material, except items specifically designed to be installed outdoors such as pad mounted transformers or stand-by generators, shall be stored in an enclosed, dry building or trailer. Areas for general storage shall be provided by the Contractor. Provide temperature and/or humidity control where applicable. No material for installation, including conductors, shall be stored other than in an enclosed weathertight structure. Equipment stored other than as specified above shall be removed from the premises.

C. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat and high humidity at all times. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

3.02 CLEANING AND PAINTING

A. Remove oil, dirt, grease and foreign materials from all raceways, fittings, boxes, panelboard trims and cabinets to provide a clean surface for painting. Touchup scratched or marred surfaces of lighting fixtures, panelboard and cabinet trims, motor control center, switchboard or equipment enclosures with paint furnished by the equipment manufacturers specifically for that purpose.

B. Do not paint trim covers for flush mounted panelboards, telephone cabinets, pull boxes, junction boxes and control cabinets unless required by the Engineer, National Electrical Code or other Sections of the specifications. Remove trim covers before painting. Under no conditions shall locks, latches or exposed trim clamps be painted.

C. Unless indicated on the drawings or specified herein to the contrary, all painting shall be done under the PAINTING Section of these Specifications.

D. Where plywood backboards are used to mount equipment provided under Division 26, paint backboards with two coats of light grey semi-gloss paint under Division 26.

3.03 EXCAVATION, TRENCHING AND BACKFILLING

A. Perform all excavation to install conduits, indicated on the drawings or specified herein. During excavation, pile material for backfilling back from the banks of the trench to avoid overloading and to prevent slides and cave-ins. Provide shoring as required by OSHA Standards. Remove and dispose of all excavated materials not to be used for backfill. Grade to prevent surface water from flowing into trenches and excavation. Remove any water accumulating therein by pumping. Do all excavation by open cut. No tunneling shall be done unless indicated on the drawings or unless written permission is received from the engineer.

B. Grade the bottom of trenches to provide uniform bearing and support for conduits on undisturbed soil at every point along its entire length. Tamp overdepths with loose, granular, moist earth. Remove unstable soil that is not capable of supporting equipment or installation and replace with specified material for a minimum of 12" below invert of equipment or installation.

C. Backfill the trenches with excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel or soft shale, free from large clods of earth and stones, deposited in 6" layers and rammed until the installation has a cover of not less than the adjacent ground but not greater than 2" above existing ground. Backfilling shall be carried on simultaneously on both sides of the trench so that injurious pressures do not occur. Compaction of the filled trench shall be at least equal to that of the surrounding undisturbed material. Do not settle backfill with water. Reopen any trenches not meeting compaction requirements or where settlement occurs, refill, compact, and restore surface to grade and compaction indicated on the drawings, mounded over and smoothed off.

D. Provide plastic tracable marking tape above all exterior conduits 12" below grade.

3.04 ELECTRICAL SYSTEMS OPERATIONAL TESTS, MANUFACTURERS SYSTEMS CERTIFICATION AND DESIGN AUTHORITY ASSISTANCE.

A. Testing

1. Refer to the individual specification sections and the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of the specifications for test requirements.
2. Prior to the final inspection, the systems or equipment shall be tested and reported as therein specified. Five (5) typewritten copies of the tests shall be submitted to the Engineer for approval.
3. All electrical systems shall be tested for compliance with the specifications.

B. Manufacturers Certifications

1. The electrical systems specified herein shall be reviewed for compliance with these specifications, installation in accordance with the manufacturers recommendations and system operation by a representative of the manufacturer. The manufacturer shall submit certification that the system has been reviewed by the manufacturer is installed in accordance with the manufacturer's recommendations and is operating in accordance with the specifications.
2. Provide manufacturers certification for the following systems:
   a. Engine Driven EPSS
   b. Fire Alarm System

C. Design Authority Assistance

1. The Contractor shall provide personnel to assist the Engineer or his representative during all construction review visits. The Contractor shall provide all necessary tools and equipment to demonstrate the system operation and provide access to equipment, including screwdrivers, wrenches, ladders, flashlights, circuit testing devices, meters, keys, radios, etc.
2. Remove equipment covers (i.e. panelboard trims, motor controls, device plates, and junction box covers) as directed for inspection of internal wiring. Accessible ceilings shall be removed as directed for inspection of equipment installed above ceilings.

3. Energize and de-energize circuits and equipment as directed. Demonstrate operation of equipment and systems as directed by the Representative.
4. The Contractor shall provide authorized representatives of the manufacturers to demonstrate to the Engineer compliance with the specifications of their respective system during or prior to the final inspection at a time designated by the Engineer. Refer to the specific specification section for additional testing requirements. Representatives of the following systems are required for demonstrations:
    a. Engine Driven EPSS
    b. Fire Alarm System

END OF SECTION

DIVISION 26 – ELECTRICAL

260519 – WIRES AND CABLES

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. The work required under this section of the specifications consists of furnishing, installation and connections of the building wiring system, 600 volts and below. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. Wiring systems for communication and alarm systems are not included in this section unless specified to be included, by reference, in the respective specification sections for alarm and communication systems.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 44: Rubber - Insulated Wire and Cables
   b. No. 83: Thermoplastic - Insulated Wires
   c. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   d. No. 486: Wire Connectors and Soldering Lugs
2. Insulated Cable Engineers Association Standards (ICEA):
   a. S-61-402: Thermoplastic Insulated Wire and Cable
3. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5: Thermoplastic Insulated Wire and Cable
4. National Fire Protection Association Publication (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers. Products produced by the following manufacturers which conform to this specification are acceptable.

1. Hydraulically applied conductor terminations:
   a. Square D
   b. Burndy
   c. Ilsco
   d. Scotch (3M)
   e. Thomas and Betts (T&B)
   f. Anderson

2. Mechanically applied (crimp) conductor terminations:
   a. Scotch (3M)
   b. Ideal
   c. Thomas and Betts (T&B)
   d. Burndy
3. Vinyl electrical insulating tape:
   a. Scotch (3M)
   b. Tomic
   c. Permacel
4. Twist-On Wire Connectors:
   a. Scotch (3M)
   b. Ideal
   c. Buchanan
5. Encapsulated insulating kits:
   a. Scotch (3M)
   b. Raychem
   c. Essex Group, Inc.

C. Performance: Conductors shall be electrically continuous and free from short circuits or grounds. All open, shorted or grounded conductors and any with damaged insulation shall be removed and replaced with new material free from defects.

PART 2- PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications.

B. All wire and cable shall be UL listed and shall bear a UL label along the conductor length at intervals not exceeding 24 inches.

C. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer cover at intervals not exceeding 24 inches.

D. Conductor size shall be a minimum of No. 12 AWG. Conductor size shall not be less than indicated on the drawings.

E. Insulation voltage level rating shall be 600 volts.

2.02 PRODUCT/MATERIALS DESCRIPTION

A. Conductors No. 10 AWG and smaller shall be solid copper, 90°C. type THHN, THWN or XHHW unless otherwise indicated on the drawings, required by the National Electrical Code, or specified elsewhere in Division 16. Where fixtures are used as raceway use 90°C type THHN or XHHN conductors.

B. Conductors larger than No. 10 AWG shall be stranded copper, 90°C,, type THHN/THWN, XHHW, unless otherwise indicated on the drawings, required by the National Electrical Code, or specified herein.

C. Fixture wire shall be No. 16 AWG silicone rubber insulated, stranded fixture wire, type SFF-2 (150°C), or No. 16 AWG thermoplastic, nylon jacketed stranded fixture wire, type TFFN (90°C). Color code as specified herein shall not be required for fixture wire; however, neutral conductor shall be identified distinctly from phase conductors.

D. Control conductors for use on 120 volt control wiring systems shall be No. 12 AWG stranded type THHN/THWN, unless indicated otherwise on the drawings.

E. Splices and taps (No. 10 AWG and smaller) - Connectors for solid conductors shall be solderless, screw-on, spring pressure cable type, 600 volt, 105°C. with integral insulation and UL approved for aluminum and copper conductors. Connectors for stranded conductors shall be crimp-on type with integral insulating cover.

F. Splices and taps (No. 8 and larger) - Hydraulically applied crimping sleeve or tap connector sized for the conductors or indent, split-bolt or bolt clamp-type connectors. Insulate the hydraulically applied connector with 90°C., 600 volt insulating cover provided by the connector manufacturer. Insulate the mechanically applied connectors with heat shrink insulator sleeve or plastic electrical insulating type. Insulator materials and installation shall be approved for the specific application, location, voltage and temperature and shall not have an insulation value less than the conductors being joined.

G. Electrical insulating tape shall be 600 volt, flame retardant, cold and weather resistant, minimally .85 mil thick plastic vinyl material; Scotch No. 88, Tomic No. 85, Permacel No. 295.

2.03 VFD CABLE

H. All feeders for motors controlled by variable frequency drives shall be served with cable specifically manufactured to mitigate the EMI and RFI effects on adjacent cables and/or conductors.

I. Acceptable manufacturers: Lapp Group USA, Belden and Alpha Wire.

J. Required characteristics for VFD power cable:

1. Class B stranded copper or tinned copper conductors with XLP/XLPE insulation.
2. Three bare copper ground conductors or integral with the cable.
3. Spiral or helical copper tape for 100% shield.
4. 1000Vminimum rating.
5. 90°C, wet or dry installation, approved for direct burial, TC-ER approved.

6. PVC outer jacket.

PART 3 - EXECUTION

3.01 EXECUTION

A. Install all wiring in raceway system.

B. Connect all conductors. Torque each terminal connection to the manufacturers recommended torque value. A calibrated torqueing tool shall be used to insure proper torque application. Any conductors nicked or ringed while removing insulation shall be replaced.

C. Do not install more conductors in a raceway than indicated on the drawings. A maximum of three branch circuits are to be installed in any one conduit, on 3 phase 4 wire system, unless specifically indicated otherwise on the drawings. A maximum of two branch circuits are to be installed in any one conduit, on 1 phase 3 wire systems, unless specifically indicated otherwise on the drawings. No two branch circuits of the same phase are to be installed in the same conduit, unless specifically indicated on the drawings.

D. Conductors shall be tested to be continuous and free of short circuits and grounds.

E. Identification

1. Conductors within pull boxes shall be grouped and identified with nylon tie straps with circuit identification tag.
2. Identify each control conductor at its terminal points with wrap around tape wire markers. I.D. to indicate terminal block and point designation, or other appropriate identifying indication.
3. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional identification requirements.

F. Color Code Conductors.

1. Color code all secondary service, feeder and branch circuit conductors. Control and signal system conductors need not be color coded.
2. Coding shall be as follows:
   a. 208Y/120 volt three phase four wire wye system - Phase A: Black, Phase B: Red, Phase C: Blue, Neutral: White
   b. 480Y/277 volt three phase four wire system - Phase A: Brown, Phase B: Orange, Phase C: Yellow, Neutral: Gray
   c. 240/120 volt single phase 3 wire system - Phase A: Black, Phase B: Red, and Neutral: White
3. Grounding conductors shall be green.
4. Conductors No. 6 and smaller shall have solid color compound insulation or continuous color finish. Conductors No. 4 and larger shall have colored phase tape. Colored tape shall be installed on conductors in every box, at each terminal point, cabinet, through manhole or other enclosure.

G. Maintain phase rotation established at service equipment throughout entire project.

H. Group and lace with nylon tie straps all conductors within enclosures, i.e. panels, motor controllers, motor control center, switchboard, switchgear, terminal cabinets and control cabinets.

I. Make splices in conductors only within junction boxes. Do not splice conductors in pull boxes, panelboards, safety switches, switchboard, switchgear, motor control center, wiring troughs or motor control enclosures.

J. Terminate conductors No. 10 AWG and smaller specified in Division 16 to be stranded, with crimp type lug or stud. Direct termination of stranded conductors without crimp terminator to terminal screws, lugs, or other points is not permitted even if terminal is rated for stranded conductors. Crimp terminal shall be the configuration type suitable for terminal point. Crimp lugs shall be applied in strict accordance with the manufacturer's written requirements.

K. Make connections between fixture junction box and fixture with fixture wire.

L. Control, communications or signal conductors shall be installed in separate raceway systems from branch circuit or feeder raceway, unless indicated otherwise on the drawings.

M. Splices in conductors installed below grade are not permitted.

N. VFD cable shall be terminated in accordance with manufacturer's recommendations. For Belden cable refer to Belden Unarmored Variable Frequency Drive (VFD) Cable Termination Guide.

END OF SECTION

DIVISION 26 – ELECTRICAL

260526 – SECONDARY GROUNDING

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. The work required under this section of the specifications consists of furnishing, installation and connections of the building secondary grounding systems. Exterior branch circuit wiring and feeder conductors extended beyond the building are included. The building electrical system shall be a 3 phase, 4 wire grounded wye system supplemented with equipment grounding system. Equipment grounding system shall be established with equipment grounding conductors; the use of metallic raceways for equipment grounding is not acceptable.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 44: Rubber - Insulated Wire and Cables
   b. No. 83: Thermoplastic - Insulated Wires
   c. No. 467: Electrical Grounding and Bonding Equipment
   d. No. 493: Thermoplastic - Insulated Underground Feeder and Branch Circuit Cables
   e. No. 486: Wire Connectors and Soldering Lugs
2. National Electrical Manufacturer's Standards (NEMA):
   a. WC-5: Thermoplastic Insulated Wire and Cable
   b. WC-7: Cross-Linked-Thermosetting Polyethylene Insulated Wire and Cable
3. National Fire Protection Association Publication (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers. Products produced by the following manufacturer which conform to this specification are acceptable.

1. Hydraulically applied conductor terminations:
   a. Square D
   b. Burndy
   c. Ilsco

   d. Scotch (3M)
   e. Thomas and Betts (T & B)
   f. Anderson
2. Mechanically applied (crimp) conductor terminations:
   a. Scotch (3M)
   b. Ideal
   c. Thomas and Betts (T & B)
   d. Burndy
3. Exothermic connections:
   a. Cadweld

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Provide all materials under this section of the specifications. All materials shall be new.

B. All materials shall be UL listed and bear a UL label.

C. Refer to the specific specification section for the description and requirements of materials mentioned herein for installation.

2.02 GROUNDING CONDUCTORS

A. Grounding electrode conductor shall be bare or green insulated copper conductor sized as indicated on the drawings.

B. Equipment grounding conductors shall be green insulated type THW, THWN, or XHHN conductors sized as indicated on the drawings. Where size is not indicated on the drawings, conductor size shall be determined from the National Electrical Code table on sizes of equipment grounding conductors.

C. Bonding jumpers shall be flexible copper bonding jumpers sized in accordance with the National Electrical Code tables for grounding electrode conductors.

2.03 TRANSFORMERS, MOTOR CONTROLLERS, AND DISCONNECT SWITCHES

A. Provide a conductor termination grounding lug bonded to the enclosure of each equipment item.

2.04 DEVICES

A. Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame.

2.05 GROUND RODS

A. Ground rods shall be 3/4" x 10'-0" copper clad steel.

B. Sectional ground rods shall be hot dip galvanized 5/8" x 10' sections with an internal stainless steel splined coupling pin.

2.06 OTHER MATERIALS

A. Ground bus shall be solid copper, 1/4" thick x 2" x 24", tapped and drilled for conductor termination lug connections.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Ground all non-current carrying parts of the electrical system, i.e., wireways, equipment enclosures and frames, junction and outlet boxes, machine frames and other conductive items in close proximity with electrical circuits, to provide a low impedance path for potential grounded faults.

B. Service entrance and separately derived electrical systems, grounding electrode system.

1. The neutral conductor of the electrical service serving the premises wiring system shall be grounded to the ground bus bar in the service equipment which shall be grounded to the cold water system, the ground rod system, and other grounding electrodes specified herein or indicated on the drawings. Grounding electrode conductors shall be installed in rigid, non-metallic conduit to point of ground connection, unless subject to physical damage in which case they shall be installed in galvanized rigid steel. Where metallic conduit is permitted, bond conduit at both ends to grounding electrode conductor with a UL bonding bushing.
2. Make connection to main water line entering the building. Make connections ahead of any valve or fittings whose removal may interrupt ground continuity. Install a bonding jumper of the same size as the grounding conductor around the water meter.
3. Bond together the following systems to form the grounding electrode system. All system connections shall be made as close as possible to the service entrance equipment and each connected at the service entrance equipment ground bus. Do not connect electrode systems together except at ground bus.
   a. Cold water piping system
   b. Ground rod system
   c. Main rebar in a foundation footing, for a concrete structure
4. Ground the neutral of all dry type transformers to building steel which shall serve as the grounding electrode for the separately derived system. In reinforced

concrete structures building steel shall be considered to be reinforcing steel of vertical columns. Make connection to building steel with an exothermic weld in a location in unfinished space where the connection will not be subject to physical abuse.

5. Ground the neutral and frame of the emergency generator to building steel and the ground rod system, which shall serve as the grounding electrode for the separately derived system. In reinforced concrete structures building steel shall be considered to be reinforcing steel of vertical columns. Make connection to building steel with an exothermic weld in a location in unfinished space where the connection will not be subject to physical abuse.
6. Grounding electrode connections to structural steel, reinforcing bars, ground rods, or where indicated on the drawings shall be with chemical exothermic weld connection devices recommended for the particular connection type. Connections to piping shall be with UL listed mechanical ground clamps.
7. Where more than one service serves a building or interconnected buildings, connect each service equipment ground bus together with a #4/0 copper conductor in PVC conduit.
8. Bonding shall be in accordance with the National Electrical Code.
9. Install ground rods where indicated on the drawings with the top of the ground rods 12" below finished grade.

C. Equipment Grounding Conductor

1. Grounding conductors for branch circuits are not shown on the drawings; however, grounding conductors shall be provided in all branch circuit raceways and cables. Grounding conductors shall be the same AWG size as branch circuit conductors.
2. Grounding conductors for feeders are typically indicated on the drawings and the raceway is sized to accommodate grounding conductor shown. Where grounding conductor size is not indicated on the drawings, conductor shall be in accordance with the equipment grounding conductor table of the National Electrical Code.
3. A grounding conductor shall be installed in all flexible conduit installations. For branch circuits, grounding conductor shall be sized to match branch circuit conductors.
4. A feeder serving several panelboards shall have a continuous grounding conductor which shall be connected to each related cabinet grounding bar.
5. The equipment grounding conductor shall be attached to equipment with bolt or sheet metal screw used for no other purpose. Where grounding conductor is stranded, attachment shall be made with lug attached to grounding conductor with crimping tool.
6. Ground all motors by drilling and tapping the bottom of the motor junction box and attaching the equipment grounding conductor to the box with a round head bolt used for no other purpose. Conductor attachment shall be through the use of a lug attached to conductor with crimping tool.

7. Equipment grounding conductors shall terminate on panelboard, switchboard, or motor control center grounding bus only. Do not terminate on neutral bus. Provide a single terminals lug for each conductor. Conductor shall terminate in the same section as the phase conductors originate. Do not terminate neutral conductors on the ground bus.

D. Other Grounding Requirements

1. Each telephone backboard shall be provided with a No. 6 grounding conductor. When backboard is located in vicinity of electrical service equipment, the "point of grounding" of this conductor shall be the main cold water service with connections made ahead of any valves or joints. Remote backboards shall use building steel as "point of grounding". Terminate conductor by stapling to backboard.
2. At each building expansion joint flexible copper bonding jumpers shall be attached to building structure by exothermic weld process. Install bonding jumpers in concealed locations that will not subject connections or jumpers to physical abuse. Install 100' on centers across expansion joints.
3. Lighting fixtures shall be grounded with a green insulated ground wire secured to the fixture with a UL listed bond lug, screw, or clip specifically made for such use.

3.02 TESTING

A. Upon completion of the ground rod installation, the Contractor shall test the installation in accordance with the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification. Grounding resistance reading shall be taken before connection is made to the building cold water piping system. Ground resistance readings shall not be taken within forty-eight hours of rainfall. Results of ground resistance readings shall be forwarded, in writing, immediately to the Architect.

END OF SECTION

DIVISION 26 – ELECTRICAL

260529 – SUPPORTING DEVICES

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. Extent of supports, anchors, sleeves and seals is indicated by drawings and schedules and/or specified in other Division - 16 sections.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:

1. Clevis hangers.
2. Riser clamps.
3. C-clamps.
4. I-beam clamps.
5. One-hole conduit straps.
6. Two-hole conduit straps.
7. Round steel rods.
8. Expansion anchors.
9. Toggle bolts.
10. Wall and floor seals.

C. Supports, anchors, sleeves and seals furnished as part of factory-fabricated equipment are specified as part of that equipment assembly in other Division - 16 sections.

D. Provide seismic supports for electrical equipment as required by occupancy. Refer to structural and architectural drawings for criteria.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements as applicable to construction and installation of electrical supporting devices.

B. NECA Compliance: Comply with National Electrical Contractors Association's "Standard of Installation" pertaining to anchors, fasteners, hangers, supports, and equipment mounting.

C. UL Compliance: Provide electrical components which are UL-listed and labeled.

PART 2- PRODUCTS

2.01 MANUFACTURED SUPPORTING DEVICES

A. General: Provide supporting devices which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation; and as herein specified. Where more than one type of supporting device meets indicated requirements, selection is Installer's option.

B. Supports: Provide supporting devices of types, sizes and materials indicated; and having the following construction features:

1. Conduit clamps, clevis hangers, round steel rod, conduit clamps, heagon nuts, etc. shall be stainless steel.

C. Anchors: Provide anchors of types, sizes and materials indicated, with the following construction features:

1. Toggle Bolts: Springhead; 3/16" x 4"; approximately 5 lbs. per 100 units.
2. Expansion sleeve anchors by Hilti or Phillips Redhead: 1/2"; approximately 38 lbs. per 100 units.
3. Manufacturers: Subject to compliance with requirements, provide anchors of one of the following:
    a. Ackerman Johnson Fastening Systems Inc.
    b. Hilti
    c. Ideal Industries, Inc.
    d. Joslyn Mfg and Supply Company
    e. McGraw Edison Company
    f. Phillips Redhead
    g. Rawlplug Company Inc.

D. Sleeves and Seals: Provide sleeves and seals, of types, sizes and materials indicated, with the following construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sizes indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.

E. Conduit Cable Supports: Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct for 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

F. U-Channel Strut Systems:

1. The approved material for u-channel strut, hardwater and associated items will be either stainless steel or aluminum.
   a. Fixture hangers.
   b. Channel hangers.
   c. End caps.
   d. Beam clamps.
   e. Wiring studs.
   f. Thinwall conduit clamps.
   g. Rigid conduit clamps.
   h. Conduit hangers.
   i. U-bolts.
2. Manufacturers: Subject to compliance with requirements, provide channel systems of one of the following:
   a. Allied Tube and Conduit Corporation.
   b. B-Line Systems, Inc.
   c. Elcen Metal Products Company.
   d. Greenfield Mfg Company, Inc.
   e. Midland-Ross Corporation.
   f. OZ/Gedney Div; General Signal Corporation.
   g. Power-Strut Div; Van Huffel Tube Corporation.
   h. Unistrut Div; GTE Products Corporation.

2.02 FABRICATED SUPPORTING DEVICES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal: 3" and smaller, 20-gage; 4" to 6", 16-gage; over 6", 14" gage.
2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
3. Iron Pipe: Fabricate from cast-iron or ductile-iron pipe.
4. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

B. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.01 INSTALLATION OF SUPPORTING DEVICES

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Remove burrs from ends of pipe sleeves.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533 – RACEWAYS

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 covers the complete interior and exterior raceway system.

B. Definition: The term conduit, as used in this Specification, shall mean any or all of the raceway types specified.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:

No. 1	Flexible Metal Electrical Conduit
No. 6	Rigid Galvanized Conduit
N. 6a	Stainless Steel Rigid Conduit
No. 467	Electrical Grounding and Bonding
No. 651	Rigid Nonmetallic Electrical Conduit
No. 797	Electrical Metallic Tubing
No. 1242	Intermediate Metal Conduit

2. American National Standards Institute (ANSI):

C-80.1	Rigid Galvanized Conduit.
C-80.3	Electrical Metallic Tubing.

3. National Fire Protection Association (NFPA):

No. 70	National Electrical Code (NEC).

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Metallic Conduit Fittings:
   a. Appleton
   b. Carlon
   c. Crouse Hinds
   d. Killark
   e. O-Z/Gedney

f. RACO
g. Thomas and Betts
h. CalPipe Industries
i. Gibson Stainless

2. Support Channel:
   a. Kindorf
   b. Powers
   c. Unistrut
3. Non-Metallic Conduit and Fittings:
   a. Carlon
   b. Certainteed
   c. Thomas and Betts

C. Coordination

1. Coordinate conduit installation with electrical equipment furnished.
2. Coordinate conduit installation with contract documents and other contractors. Adjust installation to eliminate conflicts. Review all shop drawings submitted under this and other sections to insure coordination with all equipment requiring electrical service and to avoid conflict interferences. Coordinate installation sequence with other contractors to avoid conflicts including equipment access and provide the fastest overall installation schedule.

1.04 STORAGE AND HANDLING

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section of the specifications for storage and handling requirements.

B. Non-metallic conduits stored on site prior to installation shall be stored on a surface off of the ground and shall be protected from the direct rays of the sun and from debris.

C. Damaged, oxidized, warped, improperly stored material or material with excessive amounts of foreign debris will be removed from the project and replaced with new materials.

PART 2- PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All conduit and fittings shall be listed and bear a label by Underwriters' Laboratories (UL) for use as raceway system for electrical conductors.

C. Raceway is required for all wiring, unless specifically indicated or specified otherwise.

D. Size: The minimum size of conduit shall be 3/4". The size of all conduits shall be in accordance with the NEC, but, not less than indicated on the drawings.

2.02 EMT CONDUIT FITTINGS

A. Electrical Metallic Tubing (EMT) couplings and connectors shall be steel "concretetight" type. Malleable iron, die cast or pressure cast fittings are not permitted. Fittings 2.0" and smaller shall be gland and ring compression type. Connectors for conduits 2.5" and larger shall be set screw type with two (2) screws each or compression type. Couplings for conduits 2.5" and larger shall be set screw type with four (4) screws each or compression type. All connectors shall be insulated throat type. All set screw connectors encased in walls or floor shall be taped at all joints.

2.03 STAINLESS STEEL, RIGID AND IMC CONDUIT FITTINGS

A. Fittings for rigid steel and IMC shall be standard threaded couplings, threaded hubs and elbows. All materials shall be steel or malleable iron only. Set screw or non-thread fittings are not permitted. Bushings shall be metallic insulating type consisting of insulating insert molded or locked into the metallic body of the fittings. Erickson-type couplings may be used to complete a conduit run.

2.04 NON-METALLIC CONDUIT AND FITTINGS

A. Non-metallic conduit shall be schedule 80 PVC.

B. Non-metallic conduit fittings shall be of the same material as the conduit furnished and be the product of the same manufacturer.

C. Glue for all non-metallic conduit and fittings shall be provided as required by the manufacturer of the conduit being used.

2.05 CONDUIT SUPPORTS

A. Support channel and rods shall be stainless or aluminum.

B. Conduit straps shall be single hole cast metal type or two hole galvanized metal type.

C. Conduit support channels shall be 1.5" x 1.5" x 14 gauge galvanized (or with equivalent treatment) channel. Channel suspension shall be 3/8" threaded steel rods. Use swivel type connector to attach suspension rods to structure. Spring steel clips are not acceptable. Wire or chain is not acceptable for conduit hangers. Stainless steel channels, fasteners and conduit straps shall be used on all exterior installations.

D. Individual conduit hangers shall be galvanized spring steel specifically designed for the purpose, sized appropriately for the conduit type and diameter, and have pre-assembled closure bolt and nut and provisions for receiving threaded hanger rod. Support with 1/4" threaded steel rod for individual conduits 1.5" and smaller and 3/8" rod for individual conduits 2.0" and larger.

E. Refer to SUPPORTING DEVICES section of these specifications for additional material requirements.

2.06 FLEXIBLE CONDUIT AND FITTINGS

A. Flexible conduit shall be steel metallic type. Where specified herein, indicated on the drawings, or when used in damp or wet locations, as classified by the National Electrical Code, flexible conduit shall be liquid tight.

B. All flexible conduit shall be classified as suitable for system grounding. All flexible (liquid tight) conduits shall be UL listed as sunlight (UV) resistant.

C. Connectors for flexible conduit shall be steel insulated throat type rated as suitable for system ground continuity. Connectors for liquid tight flexible conduit shall be screw-in ground cone type.

D. Flexible conduit shall not be less than 3/4" trade size and in no case shall flexible conduit size be less than permitted by the National Electrical Code for the number and size of conductors to be installed herein.

2.07 MISCELLANEOUS CONDUIT FITTINGS AND ACCESSORIES

A. Vinyl all weather electrical tape for corrosion protection shall be Scotch Temflex

B. Expansion and deflection couplings shall be in accordance with UL 467 and UL 514. They shall accommodate 3/4" deflection, expansion, or contraction in any direction and shall allow 30 degree angular deflections. Couplings shall contain an internal flexible metal braid to maintain raceway system ground continuity.

C. Fire and smoke stop materials shall be rock wool fiber, silicone foam, or silicone sealant, UL rated to maintain the fire floor or fire wall partition rating.

2.08 RIGID ALUMINUM CONDUIT FITTINGS

A. Rigid aluminum conduit fittings shall be standard threaded couplings, locknuts, bushings, and elbows. Material shall be compatible with aluminum conduit of malleable iron, steel or aluminum alloy. Iron or steel fittings shall be zinc or cadmium plated. Aluminum fittings shall not contain more than 0.4 percent copper. Threaded hubs shall be as specified for rigid steel and IMC conduit. Set screw fittings or no-thread fittings are not acceptable.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. Conceal all conduits, except in unfinished spaces such as equipment rooms or where indicated by symbol on the drawings.
2. Leave all empty conduits with a 200 pound test nylon cord pull line.
3. Install as complete raceway runs prior to installation of cables or wires.
4. Flattened, dented, burned, or deformed conduits are not permitted and shall be removed and replaced.
5. Secure rigid conduit i.e., rigid galvanized conduit, rigid aluminum conduit and intermediate metal conduit, to sheet metal enclosures with threaded hubs. Secure EMT to sheet metal enclosures with insulated throat connectors with lock nut.
6. Fasten conduit support device to structure with wood screws on wood, toggle bolts on hollow masonry, anchors as specified on solid masonry or concrete, and machine bolts, clamps, or spring steel clips, on metal studs. Nails are not acceptable.
7. Protect conduits against dirt, plaster, and foreign debris with conduit plugs. Plugs shall remain in place until all masonry is complete. Protect conduit stub-ups during construction from damage; any damaged conduits shall not be used.
8. Seal all conduits originating from outside building from below grade and all conduits entering exterior mounted electrical equipment with insulating electrical putty to prevent entrance of moisture. Spray foam is not acceptable.
9. Install conduit with wiring, including homeruns as indicated on the drawings. Any change resulting in a savings in labor or materials is to be made only in accordance with a contract change. Deviations shall be made only where necessary to avoid interferences and when approved by Engineer by written authorization.
10. Use flexible conduit for connection to vibrating equipment and rotating machinery and for connection from junction box to flush mounted lighting fixtures only.
11. Separate raceway systems are to be installed for power systems and for control, signal and communications systems. Do not install control, signal or communications cables in the same raceways as branch circuit or feeder cables, unless indicated otherwise on the drawings.
12. Provide expansion fitting in all conduits where length of run exceeds 200 feet or where conduits pass building expansion joints.

B. Uses Permitted

1. Conduits installed within concrete floor slabs which are in direct contact with grade or other material shall be galvanized rigid steel (GRS) or intermediate

metal conduit (IMC). Conduits which penetrate the building roof shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Conduits installed within concrete floor slabs which are above grade shall be galvanized rigid steel (GRS), intermediate metal conduit (IMC), or schedule 80 Heavy Wall PVC. Where transition is made from raceway in slab to any type of raceway out of slab, make transition with rigid galvanized elbow. For corrosion protection, where elbow penetrates surface, apply two coats of Scotchrap pipe primer and two overlapping layers of Scotchrap Temflex tape, for 6" above and below concrete surface.

2. Conduits installed in direct contact with earth shall be schedule 80, heavy wall PVC.
3. Service entrance conduits in direct contact with earth shall be PVC. Other conduit in direct contact with earth shall be schedule 80, heavy wall PVC.
4. All other conduit, unless excluded herein, not permitted in accordance with the National Electrical Code, or otherwise indicated on the drawings, shall be electrical metallic tubing (EMT).
5. Conduit types shall not be mixed indiscriminately with other types in the same run, unless specified herein or required by the NEC.
6. Use flexible conduit for connections to motors, dry type transformers and unit heaters.
   a. Flexible conduit used for connection of motors, dry type transformers, electric duct heaters, unit heaters, busway tap devices and voltage regulators shall not exceed 18" in length.
   b. Maintain ground continuity through flexible conduit with green equipment grounding conductor; do not use flexible conduit for ground continuity.
   c. Liquid tight conduit shall be used to connect equipment in mechanical equipment rooms and exterior installations.
7. Feeder conduits installed exposed or concealed in walls or above ceilings shall be galvanized rigid steel (GRS) or intermediate metal conduit (IMC). Service entrance conduits shall be installed "outside" of the building as defined by the NEC. Provide concrete encasement where required.
8. No conduit requiring cutting of cross-webs of concrete masonry units is permitted. Conduit shall be threaded through cells or concrete masonry units lowered around conduit. Neither horizontal joint reinforcement nor bond beam reinforcement shall be cut for conduit installation. Conduits shalal not be run horizontally in walls.
9. Rigid aluminum conduit may be used for all trade sizes 3.0" and larger for conduits not installed in concrete slabs, not installed in direct contact with earth, not installed in hazardous locations as defined by Article 500 of the National Electrical Code and not installed in areas exposed to excessive moisture.
10. All conduits installed exposed from the finished floor to a minimum height of 10 ft. above the floor shall be galvanized rigid steel (GRS).

11. Where hazardous locations, as classified by the National Electrical Code, exist, all conduits and fittings and the installation of these materials shall comply with Article 500 of the National Electrical Code.

C. Below Grade Raceway Installations

1. Direct Burial Conduit
   a. Install top of conduits 24" minimum below finished grade. Maximum depth shall be 36".
   b. Install top of conduits 6" minimum below bottom of building slabs.
   c. Install top of conduits 30" minimum below grade, below roads and any other paved surfaces.
   d. Where transition is made from below grade PVC installation to a metallic conduit system above grade or slab, make transition with rigid galvanized elbow and extend through slab or above grade with galvanized rigid steel conduit. For corrosion protection, where the elbow penetrates surface, apply two coats of Scotchrap pipe primer and two overlapping layers of Scotchrap Temflex tape, for 6" above and below concrete surface.
   e. For excavation and backfilling, refer to earthwork specification section.
   f. Conduit shall be run following the most direct route between points.

D. Raceway Installations Within Concrete

1. Conduit shall be run following the most direct route between points.
2. Conduit shall not be installed in concrete which is less than 3" thick or where the outside diameter is larger than 1/3 of the slab thickness.
3. Conduits installed in concrete slabs shall be buried in the concrete slab. Wire low conduits to upper side of the bottom reinforcing steel, and upper conduits to the lower side of the top reinforcing steel. Separate parallel runs of conduits within slab by at least 1".
4. Conduits shall not be installed within shear walls unless specifically indicated on the drawings. Conduits shall not be run directly below and parallel with load bearing walls
5. Protect each metallic conduit installed in concrete slab or conduits 1.5" and smaller passing through a concrete slab against corrosion where conduit enters and leaves concrete by wrapping conduit with vinyl all-weather electrical tape.
6. The maximum projection of conduit stub-up and bushing above slab shall be 3" in equipment rooms.
7. Protect all conduits entering and leaving concrete floor slabs from physical damage during construction.

E. Concealed (Above Ceilings and in Walls) and Exposed Raceway Installation

1. Conduit shall be run parallel or at right angles to existing walls, ceilings, and structural members.
2. Support branch circuit conduits at intervals not exceeding 10 ft. and within three feet of each outlet, junction box, cabinet or fitting. Attach individual branch circuit conduits to structural steel members with beam conduit clamps and to

non-metallic structural members with one hole conduit straps. For exposed conduits and where conduits must be suspended below structure, single conduit runs shall be supported from structure by hangar rod and conduit clamp assembly. Multiple conduits shall be supported by trapeze type support suspended from structure. Do not attach conduits to ceiling suspension system channels or suspension wires.

3. Attach feeder conduits larger than 1" trade diameter to or from structure on intervals not exceeding 12 ft. with conduit beam clamps, one hole conduit straps or trapeze type support in accordance with support systems described for branch circuit conduits.
4. Where conduits must pass through structural members, obtain approval of Engineer with respect to location and size of hole prior to drilling.
5. Install conduit sleeves in slabs where conduits 2.0" and larger pass through. Sleeves shall extent 1" minimum above finished slab. Seal all spare sleeves and between conduits and sleeves to make watertight.
6. Seal all conduit penetrations, sleeves and conduits penetrating chemical room walls and ceilings to prevent the migration of hazardous gases.
7. Conduits rigidly secured to building construction on opposite sides of a building expansion joint shall be provided with an expansion and deflection coupling. In lieu of an expansion coupling, conduits 2-1/2" and smaller may be provided with junction boxes on both sides of the expansion joint connected by 15" of slack flexible conduit with bonding jumper.

3.02 ADJUSTMENT, CLEANING AND PROTECTION

A. Clean: Upon completion, clean all installed materials of paint, dirt, and construction debris. All conduit systems shall be cleaned of water and debris prior to the installation of any conductors.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533.01 – BOXES

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. The work required under this section of the specifications consists of the installation of outlet boxes, pull boxes, and junction boxes throughout the wiring system including box supports.

B. Definition: Box, as used in this specification, includes all outlet, device, junction, and pull boxes. Feeder shall mean all conductor circuits larger than #8 AWG, including service entrance conductors, and all wiring above 600V.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 50: Electrical Cabinets and Boxes
   b. No. 467: Electrical Grounding and Bonding Equipment
   c. No. 514: Electrical Outlet Boxes and Fittings
2. National Fire Protection Association (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Coordination: Review architectural drawings for areas where outlets occur within specific architectural or structural features and install outlets as shown on architectural drawings; or if not shown, accurately center and align boxes within the architectural features or detail.

C. Acceptable Manufacturers:

1. Exterior junction or pull boxes:
   a. Quaztite: Type PG
   b. Old Castle Synertech
   c. Penecel

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All boxes shall be UL listed and labeled.

C. Boxes shall be galvanized steel sheet metal, unless rustproof cast metal is specified or required by the NEC, or unless otherwise specified or indicated on the drawings.

2.02 OUTLET AND DEVICE BOXES

A. Outlet boxes for surface mounted and pendant mounted lighting fixtures shall be 4" octagon boxes, 1-1/2" deep.

B. Outlet boxes for flush mounted lighting fixtures shall be 4" square boxes 1-1/2" deep, with blank cover, installed adjacent to fixture. Connection to fixture shall be with flexible conduit and fixture wire.

C. Outlet boxes for switches, receptacles and wall mounted junction boxes shall be 4" square boxes, 1-1/2" deep with square edge tile type cover. Where only one conduit enters box, 3-1/2" deep single gang switch box may be used. Outlet boxes for GFI receptacles shall be 2-3/4" deep.

D. Outlet boxes for switches and receptacles in exposed wiring system shall be cast FS boxes with matching device plate. Device plates for exterior installations shall be spring loaded hinged covers. Use FD box for GFI receptacle.

E. Outlet boxes for individual switches, and receptacles flush mounted in exposed concrete block shall be single gang masonry boxes 3-1/2" deep.

F. Where special purpose device specified requires larger outlet box than specified herein, provide outlet box suitable for specific device. These outlet boxes shall be of the same type as specified herein for the installation required.

G. Outlet boxes installed in poured concrete or cast in place shall be concrete-tight type. The box depth shall allow 2" minimum of concrete cover.

2.03 JUNCTION AND PULL BOXES

A. Dimensions of pull boxes and junction boxes shall not be less than those dimensions required by the National Electrical Code for the number, size and position of conductors entering the box. Extension rings shall not be permitted on a box to increase the volume.

B. Pull boxes installed in finished spaces shall be flush mounted cabinets provided with trim, hinged door and flush latch and lock to match panel trim for flush mounted electrical panelboard.

C. Pull boxes required for horizontal feeders containing more than one feeder shall be provided with reinforced flange and removable 12 gauge 1-1/2" x 1-1/2" galvanized channel for support of conductors. Wood supports within pull boxes are not acceptable.

D. Provide box covers for all junction and pull boxes.

2.04 EXTERIOR JUNCTION OR PULL BOXES, FLUSH WITH GRADE

A. Junction or pull box to be mounted flush with grade shall be as indicated on the drawings. Provide polymer concrete, tier 22 traffic rated sized in accordance with the National Electrical Code minimum requirements. Covers shall be polymer concrete, tier 22 traffic rated with identifying system (i.e. Electrical) in cover secured to box with stainless steel bolts. Conduit entry shall be by field drilled openings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All boxes shall be completely accessible and as required by the NEC. Provide access panels in any non-accessible spaces to allow access to boxes installed. Crawling above ceilings to access boxes is not acceptable.

B. Provide an outlet box for each lighting fixture and for each device. Boxes shall not be smaller than indicated in this section of the specifications and shall be larger if required by Article 314 of the National Electrical Code for the number and size of conductors installed. Where lighting fixtures are installed in continuous rows, only one outlet box shall be required.

C. Outlet boxes for flush mounted lighting fixtures shall be accessible. Where fixture installation is in nonaccessible ceiling, outlet box shall be accessible when fixture is removed.

D. Set outlet boxes for flush mounted devices to within 1/8" of finished wall. Spacers or shims between box and device are not acceptable. Modification of boxes or use of extensioin rings to provide for 1/8" of finished wall is not acceptable.

E. Where low voltage device is to be installed in common outlet boxes with line voltage device, provide metal barrier within outlet box to establish two separate compartments.

F. Where drawings indicate ganged installations of switches controlling 277 volt lighting circuits of opposite phase, separate switches with permanently installed nonmetallic barrier. Where space available for horizontal ganged installation is not adequate, install switches vertically to maintain required clearances between energized terminals.

G. Support every box from structure:

1. Secure to wood with wood screws.
2. Secure to hollow masonry with toggle bolts.
3. Secure to metal with sheet metal screws, machine bolts, or clamps.
4. Anchors for solid masonry and concrete shall be self drilling expansion shields, insert expansion shields, or lead shields with machine bolts. Power actuated pin studs may be used in concrete.
5. Secure outlet boxes to metal studs with spring steel clamp which wraps around entire face of stud and digs into both sides of stud. Clamp shall be screwed into stud.
6. Where box is suspended below structure, support from structure with threaded steel rod. Secure rod directly to outlet boxes with double nuts. For pull boxes larger than 18" x 18" x 6", construct 1-1/2" x 1-1/2" x 14 gauge metal channel frame. Connect frame to box by bolting and secure frame to threaded rod at each corner.
7. Hub type cast boxes need not be directly attached to structure if rigid conduit is used and supported in conformance with the NEC.

H. Support outlet boxes for support of surface mounted incandescent lighting fixtures by light weight channel spanning between and attached to main ceiling support member. Attach channel to ceiling support members with galvanized tie wire or nylon tie straps.

I. Do not use outlet boxes for support of lighting fixtures; boxes shall be used only as junction boxes.

J. Remove only knockouts as required and plug all unused openings. Use threaded plugs for cast boxes and snap-in metal plugs for sheet metal boxes.

K. Outlet boxes in the same wall shall not be mounted back-to-back. Offset 6" minimum.

L. Install pull boxes only in unfinished spaces or concealed above ceilings, except when indicated on the drawings or approved by the Engineer.

M. Install pull boxes when any of the following conditions apply:

1. Where indicated on the drawings.
2. Where conduit run exceeds 200 ft. from box to box or box to terminal.
3. Where conduit contains more than 4-90 degree bends or the equivalent offsets.

4. To facilitate conductor installation or to insure that the manufacturer's maximum pulling tension is not exceeded.
5. As described in the RACEWAYS section of the specifications for crossing expansion joints.

N. Do not splice conductors in pull boxes. Splices are not permitted in pull boxes except when approved in writing by the Engineer or where shown on the drawings. Where splices are permitted, make splices with splicing sleeves attached to conductors with hydraulic crimping tool. Split bolt connectors are not acceptable for splices within pull boxes.

O. Where a pull box is required, one shall be installed for each individual branch circuit conduit or each feeder. It shall contain only the feeder conductors or those conductors in the conduit. A combined pull box for multiple branch conduits or feeders is not permitted, unless approved by the Engineer or indicated on the drawings. Where permitted for multiple circuits within pull box:

1. Circuit conductors and feeders shall be individually laced with nylon tie straps of the type with enlarged tab to permit identification of each circuit and feeder within pull box. Identify each with respect to load served.
2. Feeder circuits shall be wrapped, in accordance with manufacturer's recommendations, with arc-proof and fire proof tape.

P. Box covers shall be in place and secured to box.

Q. Identification

1. Refer to ELECTRICAL IDENTIFICATION section of these specifications for additional requirements.

R. Exterior pull or junction boxes

1. Exterior pull or junction boxes shall be mounted flush with the grade, unless specified elsewhere or indicated to be aboveground on the drawings.
2. Flush mounted boxes shall be surrounded on all sides and bottom with 6" minimum of concrete. Top of concrete shall be flush with grade.
3. Seal conduit entries into box with duct seal to prevent entrance of moisture, after conductors are installed.
4. Taps and splices, where permitted by these specifications within exterior junction boxes, shall be performed with an encapsulating watertight splice or tap kit which insulates and moisture seals the connection. Kit shall consist of the appropriate size and type mold, encapsulating resin and end sealing tape.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean all work of dirt, paint and construction debris.

END OF SECTION

DIVISION 26 – ELECTRICAL

260533.02 – ELECTRICAL CONNECTIONS FOR EQUIPMENT

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. Extent of electrical connections for equipment is indicated by drawings and schedules. Electrical connections are hereby defined to include connections used for providing electrical power to equipment.

B. Applications of electrical power connections specified in this section include the following:

1. To resistive heaters.
2. From electrical source to motor starters.
3. From motor starters to motors.
4. To lighting fixtures.
5. To transformers and similar current current adjustment features of equipment.

C. Electrical connections for equipment, not furnished as integral part of equipment, are specified in Division - 15 and other Division - 16 sections, and are work of this section.

1. Division 1 - GENERAL REQUIREMENTS
2. Division 11 - EQUIPMENT
3. Division 13 - SPECIAL CONSTRUCTION

D. Motor starters and controllers, not furnished as integral part of equipment, are specified in applicable Division - 16 sections, and are work of this section.

E. Junction boxes and disconnect switches required for connecting motors and other electrical units of equipment are specified in applicable Division - 16 sections, and are work of this section.

F. Raceways and wires/cables required for connecting motors and other electrical units of equipment are specified in applicable Division 16 sections, and are work of this section.

G. Electrical identification for wire/cable conductors is specified in Division - 16 section, ELECTRICAL IDENTIFICATION, and is work of this section.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with applicable requirements of NEC as to type products used and installation of electrical power connections (terminals and splices), for junction boxes, motor starters, and disconnect switches. NEC Article 110-14, "ELECTRICAL CONNECTIONS" applies to above.

B. IEEE Compliance: Comply with Std 241, "IEEE Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to connections and terminations.

C. ANSI/NEMA Compliance: Comply with applicable requirements of ANSI/NEMA and ANSI/EIA standards pertaining to products and installation of electrical connections for equipment.

1. ANSI/NEMA CC3: "Connectors for use between aluminum or aluminum-copper overhead conductors."
2. ANSI/EIA RS-364-21A: "Insulation Resistance Test"
3. STD SG-14: "Unplated split-bolt and Vice-Type Electrical Connectors for Copper Conductors".

D. UL Compliance: Comply with UL Std 486A, "Wire Connectors and Soldering Lugs for Use With Copper Conductors" including, but not limited to, tightening of electrical connectors to torque values indicated. Provide electrical connection products and materials which are UL-listed and labeled.

1. STD. NO. 486A; Wire Connectors and Soldering Lugs for Use with Copper Conductors.
2. STD. No. 486B; Wire Connectors for Use with Aluminum Conductors.
3. STD. NO. 486C; Splicing Wire Connectors.
4. STD. NO. 486D; Insulated Wire Connectors for Use With Underground Conductors.

E. ETL Compliance: Provide electrical connection products and materials which are ETL-listed and labeled.

F. ASTM Compliance: Comply with Standard B539 "Standard Methods for Measuring Contact Resistance of Electrical Connections (Static Contacts)."

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver electrical connection products wrapped in proper factory-fabricated type containers.

B. Store electrical connection products in original cartons and protect from weather, construction traffic and debris.

C. Handle electrical connection products carefully to prevent breakage, denting, and scoring finish.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of product):
1. AMP Incorporated
2. Appleton Electric Company
3. Arrow-Hart Div, Crouse-Hinds Company
4. Bishop Div, General Signal Corporation
5. Burndy Corporation
6. General Electric Company
7. Gould, Inc.
8. Harvey Hubbell Inc.
9. Ideal Industries, Inc.
10. Reliable Electric Company
11. Square D Company
12. Thomas and Betts Corporation

2.02 MATERIALS AND COMPONENTS

A. General: For each electrical connection indicated, provide complete assembly of materials, including but not necessarily limited to, pressure connectors, terminals (lugs), electrical insulating tape, heat-shrinkable insulating tubing, cable ties, solderless wire-nuts, and other items and accessories as needed to complete splices and terminations of types indicated.

B. Metal Conduit, Tubing and Fittings:

1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) indicated for each type service. Where types and grades are not indicated, provide proper selection as determined by Installer to fulfill wiring requirements and comply with NEC requirements for raceways. Provide products complying with Division - 16 BASIC ELECTRICAL MATERIALS and RACEWAYS section, and in accordance with the following listing of metal conduit, tubing and fittings:
   a. Rigid aluminum conduit
   b. Rigid steel conduit
   c. Rigid metal conduit fittings
   d. Electrical metallic tubing
   e. EMT fittings
   f. Flexible metal conduit
   g. Flexible metal conduit fittings

h. Liquid-tight flexible metal conduit
i. Liquid-tight flexible metal conduit fittings
j. Stainless steel conduits and fittings

C. Wires, Cables, and Connectors:

1. Provide wires, cables, and connectors complying with Division - 16 basic electrical materials and methods section "WIRES AND CABLES".
2. Wires/Cables: Unless otherwise indicated, provided wires/cables (conductors) for electrical connections which match, including sizes and ratings, of wires/cables which are supplying electrical power. Provide copper conductors with conductivity of not less than 98% at 20°C (68°F).
3. Connectors and Terminals: Provide electrical connectors and terminals which mate and match, including sizes and ratings, with equipment terminals which are recommended by equipment manufacturer for intended applications.
4. Electrical Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing and boots, wirenuts and cable ties as recommended for use by accessories manufacturers for type services indicated.

PART 3 - EXECUTION

3.01 INSTALLATION OF ELECTRICAL CONNECTIONS:

A. Install electrical connections as indicated; in accordance with equipment manufacturer's written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC and NECA's "Standard of Installation" to ensure that products fulfill requirements.

B. Coordinate with other work, including wires/cables, raceway and equipment installation, as necessary to properly interface installation of electrical connections for equipment with other work.

C. Connect electrical power supply conductors to equipment conductors in accordance with equipment manufacturer's written instructions and wiring diagrams. Mate and match conductors of electrical connections for proper interface between electrical power supplies and installed equipment.

D. Cover splices with electrical insulating material equivalent, or of greater insulation resistivity rating, than electrical insulation rating of those conductors being spliced.

E. Prepare cables and wires by cutting and stripping covering armor, jacket, and insulation properly to ensure uniform and neat appearance where cables and wires are terminated. Exercise care to avoid cutting through tapes which will remain on conductors. Also avoid "ringing" copper conductors while skinning wire.

F. Trim cables and wires as short as practicable and arrange routing to facilitate inspection, testing and maintenance.

G. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturers published torque tightening values for equipment connectors. Accomplish tightening by utilizing proper torquing tools, including torque screwdriver, beam-type torque wrench, and ratchet wrench with adjustable torque settings. Where manufacturer's torquing requirements are not available, tighten connectors and terminals to comply with torquing values contained in UL 486A.

H. Provide PVC conduit and fittings as indicated for highly corrosive atmospheres.

I. Provide flexible conduit for motor connections, and other electrical equipment connections, where subject to movement and vibration.

J. Provide liquid-tight flexible conduit for connection of motors and other electrical equipment where subject to movement and vibration, and also where connections are subject to one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmosphere where condensate can be expected to accumulate.
3. Corrosive atmosphere.
4. Water spray.
5. Dripping oil, grease, or water.

K. Fasten identification markers to each electrical power supply wire/cable conductor which indicates their voltage, phase and feeder number in accordance with Division - 16 section ELECTRICAL IDENTIFICATION. Affix markers on each terminal conductor, as close as possible to the point of connection.

3.02 FIELD QUALITY CONTROL

A. Upon completion of installation of electrical connections, and after circuitry has been energized with rated power source, test connections to demonstrate capability and compliance with requirements. Ensure that direction of rotation of each motor fulfills requirement. Correct malfunctioning units at site, then retest to demonstrate compliance.

END OF SECTION

DIVISION 26 – ELECTRICAL

260553 – 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. Extent of electrical identification work is as outlined by this specification.

B. Types of electrical identification work specified in this section include the following:

1. Buried cable warnings.
2. Electrical power, control and communication conductors.
3. Operational instructions and warnings.
4. Danger signs.
5. Equipment/system identification signs.

C. Refer to Division 1 General Requirements section IDENTIFICATION SYSTEMS, for equipment and system nameplates, and performance data; not work of this section.

1.03 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation of identifying labels and markers for wiring and equipment.

B. UL Compliance: Comply with applicable requirements of UL Std 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

C. ANSI Compliance: Comply with applicable requirements of ANSI Std A13.1, "Scheme for the Identification of Piping Systems".

D. NEMA Compliance: Comply with applicable requirements of NEMA Std No's WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2- PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide electrical identification products of one of the following (for each type marker):

1. Almetek
2. Brady, W.H. Company
3. Calpico Inc.
4. Cole-Flex Corporation
5. Direct Safety Company
6. George-Ingraham Corporation
7. Griffolyn Company
8. Ideal Industries, Inc.
9. LEM Products, Inc.
10. Markal Company
11. National Band and Tag Company
12. Panduit Corporation
13. Seton Name Plate Company
14. Tesa Corporation

2.02 ELECTRICAL IDENTIFICATION MATERIALS

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

B. Color-Coded Plastic Tape:

1. Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 1-1/2" wide.
   a. Colors: Unless otherwise indicated or required by governing regulations, provide orange tape.

C. Underground-Type Plastic Line Marker:

1. Manufacturer's standard permanent, detectable, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried cable.

D. Cable/Conductor Identification Bands:

1. Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

E. Plasticized Tags:

1. Manufacturer's standard pre-printed or partially pre-printed accident-prevention and operational tags, of plasticized card stock with matt finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording, e.g., DANGER, CAUTION, DO NOT OPERATE.

F. Self-Adhesive Plastic Signs:

1. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.
2. Colors: Unless otherwise indicated, or required by governing regulations, provide white signs with black lettering.

G. Baked Enamel Danger Signs:

1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20-gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH.

H. Engraved Plastic-Laminate Signs:

1. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in sizes and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/8", except as otherwise indicated.
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

2.03 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION

A. General Installation Requirements:

1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC and OSHA.
2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.
3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Box Identification:

1. After completion, using an indelible wide tip marker, indicate on the cover of each junction and pull box the designation of the circuits contained therein, i.e., A-1, 3, 5. Use a black marker for normal power circuits and a red marker for emergency circuits.

C. Underground Conduit Identification:

1. During back-filling/top-soiling of each exterior underground electrical, signal or communication conduit, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in a common trench and do not exceed an overall width of 16", install a single line marker.
2. Install line marker for every buried conduit, regardless of whether direct-buried or protected in conduit.

D. Cable/Conductor Identification:

1. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work. Refer to WIRES AND CABLES section of these specifications for color coding requirements.

E. Operational Identification and Warnings:

1. Wherever required by OSHA or directed by the Owner, to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities equipment by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are

needed, provide plasticized tags with clearly written messages adequate for intended purposes.

F. Danger Signs:

1. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work or the Owner as constituting similar dangers for persons in or about project.
   a. High Voltage: Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
   b. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, or damage to or loss of property.
2. Provide DANGER signs on covers of all panels, switchboard and motor control centers.

G. Equipment/System Identification:

1. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/-control/signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated provide single line of text, 1/2" high lettering, on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
   a. Panelboards, electrical cabinets and enclosures.
   b. Access panel/doors to electrical facilities.
   c. Major electrical switchgear.
   d. Motor control centers.
   e. Transformers.
   f. Power generating units.
   g. Automatic transfer switch.
2. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate. Identification of flush mounted cabinets and panelboards shall be on the inside of the device.
3. Panelboards, individually mounted circuit breakers, and each feeder breaker in the distribution panels shall be identified with an engraved plastic laminate sign. Plastic nameplates shall be multicolored laminated plastic with faceplate and core as scheduled. Lettering shall be engraved minimum 1/4" high letters.
   a. 480/277 volt normal power equipment shall be identified with white faceplate with black core.

b. 480/277 volt emergency power equipment shall be identified with white faceplate with red core.
c. 208/120 volt essential power equipment shall be identified with red faceplate with white core.
d. Equipment identification is to indicate the following:
   1) Equipment ID abbreviation.
   2) Voltage, phase, wires and frequency.
   3) Emergency or other system.
   4) Power source origination. Example:
      a) Panel E3HA
      b) 480/277V, 3 phase, 4 wire
      c) Emergency System
      d) Fed by SWBD-7

END OF SECTION

DIVISION 26 – ELECTRICAL

260573 – SHORT-CIRCUIT COORDINATION STUDY/ARC FLASH

PART 1 - GENERAL

1.01 SCOPE

A. The contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by the equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.02 RELATED SECTIONS

1.03 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories
5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace
3. submittals for review/approval

D. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.04 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. Additional copies, where required, shall be provided on CD in PDF format.

B. The report shall include the following sections:

1. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
2. Descriptions, purpose, basis and scope of the study
3. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (automatic transfer switches, circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
4. Protective device time versus current coordination curves with associated one line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
5. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
6. Incident energy and flash protection boundary calculations
7. Comments and recommendations for system improvements, where needed
8. Executive Summary including source of information and assumptions made

1.05 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCT

2.01 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer. By using the equipment manufacturer the study allows coordination of proper breakers, fuses, and current transformers. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480 Volt motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

2.02 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.03 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Typical calculations
6. Tabulations of calculated quantities
7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses
3. Adequacy of transformer windings to withstand short-circuit stresses
4. Cable and busway sizes for ability to withstand short-circuit heating

5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.04 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility's protective device
2. Medium voltage equipment relays
3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points
9. Pertinent generator short-circuit decrement curve and generator damage point
10. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.05 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Alternative methods shall be presented in the proposal.

C. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all 480V locations and significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

2.06 REPORT SECTIONS

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios
2. Short-circuit reactance of rotating machines with associated X/R ratios
3. Cable type, construction, size, # per phase, length, impedance and conduit type
4. Bus duct type, size, length, and impedance
5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, # per phase, and length

B. Short-Circuit Data:

1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA

6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
   a. Current transformer ratio.
   b. Current setting.
   c. Time setting.
   d. Instantaneous setting.
   e. Specialty non-overcurrent device settings.
   f. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground).
   b. Adjustable time-current characteristic.
   c. Adjustable instantaneous pickup.
   d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations.

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

E. Provide trip information for distribution equipment to have 'test' switch to allow work on energized equipment.

3.02 ARC FLASH WARNING LABELS

A. The vendor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The label shall have an orange header with the wording, "WARNING, ARC FLASH HAZARD", and shall include the following information:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects, one arc flash label shall be provided
2. For each motor control center, one arc flash label shall be provided
3. For each low voltage switchboard, one arc flash label shall be provided
4. For each switchgear, one flash label shall be provided

E. Labels shall be field installed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

3.03 ARC FLASH TRAINING

A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals.

END OF SECTION

DIVISION 26 – ELECTRICAL

262200 – TRANSFORMERS

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. The work required under this section of the specifications consists of the furnishing, connection and installation of dry type transformers.

B. Definition: Dry type transformers, as described herein, applies to those with primary and secondary voltage connections of 600 volts and less. Autotransformers are not acceptable, except where indicated for buck boost or zig-zag connections.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standards: The following specifications and standards are incorporated into and become a part of this specification by reference.

1. Underwriter's Laboratories, Inc. (UL) Publications:
   a. No. 506 Transformers (1000 KVA, 3 phase and below; 167 KVA, 1 phase and below)
2. National Fire Protection Association (NFPA):
   a. No. 70 National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA):
   a. No. ST-20 Dry-type transformers for general applications
4. American National Standards Institute (ANSI):
   a. No. C57.12.80 Terminology for Power and Distribution Transformers
   b. No. C57.12.90 Guide for Short Circuit Testing of Distribution and Power Transformers
   c. No. C57.94 Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Eaton
2. Siemens
3. Square D

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure transformer access and clearance minimums are provided, and adequate ventilation is permitted.

1.04 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Manufacturers Product Data:

1. Submit material specifications and installation data for products specified under PART 2 - PRODUCTS. Product data shall indicate sound and temperature rating, overload capacity and efficiency at 25%, 50% and 100% load, available taps, voltage, impedance, nameplate data, wiring diagrams, physical dimensions and net weight. Product data shall also contain certification that transformers are constructed and tested in accordance with standards specified herein.

C. Record Drawings. Include in each set:

1. A complete set of manufacturers product data indicating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein and indicated on the drawings.

B. All transformers shall be UL listed and bear a UL label.

C. Transformers shall be self-cooled, rated for continuous operation at rated KVA, 24 hours per day, 365 days per year with normal life expectancy (IEEE Standard No. 65). KVA ratings shall be as indicated on the drawings.

2.02 GENERAL PURPOSE DRY TYPE TRANSFORMERS

A. Insulation System

1. Single phase 25 - 167 KVA and three phase 30 - 1500 KVA: Transformers shall be rated for average temperature rise by resistance of 150°C. in 40°C. maximum ambient, 30°C average ambient. Transformer insulation system shall be UL rated as 220°C. system.
2. Three phase 3 - 15 KVA: Transformers shall be rated for average temperature rise by resistance of 115°C. Insulation system shall be 180°C.

3. Single phase up through 250 VA: Transformers shall be rated for 55°C. rise by resistance. Insulation system shall be 105°C.
4. Single phase 500 - 3000 VA: Transformers shall be rated for 115°C. temperature rise by resistance. Insulation system shall be 180°C.

B. Sound rating shall not exceed NEMA and ANSI standards for KVA rating. Internal vibration dampening shall be provided as a standard feature of all transformers.

C. Single phase transformers rated up to 15 KVA shall have two, 5 percent full capacity taps below normal rated primary voltage. All other single phase and all three phase transformers shall be provided with six 2-1/2% full capacity taps, two above and four below normal voltage unless only four 2-1/2% taps, two above and two below normal voltage, are standard.

D. Construction and Enclosures

1. Transformers 30 - 1500 KVA: Transformer enclosures shall be open, ventilated, drip-proof with removable front and rear cover panels. Transformers shall be suitable for floor mounting, unless wall mounting is indicated on the drawings.
2. Transformers up through 25 KVA: Transformers shall be totally enclosed, non-ventilated with a resin encapsulated core and coil and drip-proof housing. Removable panel section shall permit access to wiring compartment.

E. Dry type transformers shall provide 3 phase 4 wire 208Y/120 or 1 phase 3 wire 230/115 volt service, as indicated on the drawings, to designated panelboards or other equipment. Primary rating shall be 480 volts.

F. Nominal transformer impedance shall be 4.5 percent minimum, unless otherwise indicated on the drawings.

G. Dry type transformer K-factors shall be as indicated on the drawings and as outlined in ANSI C57.110 "Recommended Practice for Establishing Transformer Capability when Supplying Nonsinusoidal Load Currents."

H. Core assemblies and the center ground connection point of the coil secondaries shall be grounded to their enclosures by adequate, flexible ground straps. Provide grounding lug at the strap to enclosure bonding location for connection of three conductors; the primary and secondary equipment grounding conductors and the grounding electrode conductor.

I. Provide weather shield on transformers indicated on drawings and for all exterior installations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Dry transformers larger than 15 KVA shall be floor mounted, unless wall or suspension mounting is indicated on the drawings. Transformers 15 KVA and smaller shall be wall mounted. Installation shall provide not less than twelve inch clearance from walls or equipment. Floor mounted transformers shall be mounted on neoprene, waffle type vibration pads 5/8" thick. Where transformers are indicated on the drawings, or specified herein to be mounted on suspended channels of angles or wall mounted, transformers shall be bolted to structure with 5/8" thick vibration pad between transformer base and structural surface. Loosen shipping bolts to free up internal vibration mounts on core and coil assembly.

B. Primary and secondary connections to dry type transformers shall be made with flexible conduit.

C. The secondary windings of each dry type transformer shall be grounded in accordance with the National Electrical Code requirements for separately derived electrical systems. Extend a grounding electrode conductor from the transformer grounding lug to the nearest building structural steel or main column rebar. Connect the primary and secondary feeder equipment grounding conductors to the grounding lug. Refer to the secondary grounding section of these specifications for additional requirements.

D. Install secondary overcurrent protective device within 10 feet of conductor length. Where none is indicated on plans, provide enclosed circuit breaker within 10 feet rated at 125 percent of the transformer full load ampacity but not greater than the secondary conductor ampacity.

E. Do not install equipment over transformer, unless indicated on the drawings.

F. Locate transformers to provide working clearance and full accessibility as required by the National Electrical Code.

3.02 CLEANING AND ADJUSTMENT

A. Prior to final inspection, under maximum available load, measure secondary voltage and adjust tap setting to deliver nominal rated voltage within the percentage limits of one tap setting. Record the voltages of each transformer and submit in accordance with the requirements specified in the basic electrical requirements section.

B. After completion, clean the interior and exterior of dirt, paint and construction debris.

C. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.03 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.04 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

END OF SECTION

DIVISION 26 – ELECTRICAL

262413.01 – SWITCHBOARDS – FRONT ACCESSIBLE GROUP MOUNTED FEEDER DEVICES

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. The work required under this section of the Specifications consists of the installation of all switchboards for use on systems 600 volts and below. All materials and devices which are an integral part of the switchboard shall be provided under this section of the specifications.

B. Definition: Switchboards are floor mounted assemblies of one or more enclosed vertical section containing circuit breakers, switches, meters, fuses, and terminals essential to operation of electrical equipment. A dead front switchboard has no exposed live parts on front.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. National Electrical Manufacturers Association (NEMA) Standards:
   a. PB-2: Dead Front Distribution Switchboards
   b. PB-2.1: General Instruction for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards rated 600 volts or less.
   c. SG-3: Low Voltage Power Circuit Breakers.
2. Underwriters Laboratories, Inc. (UL):
   a. UL-489: Molded Case Circuit Breakers and Circuit Breaker Enclosures
   b. UL-891: Deadfront Electrical Switchboards
   c. UL-977: Fused Power Circuit Devices
3. Institute of Electrical and Electronics Engineers (IEEE):
   a. STD-241: IEEE Recommended Practices for Electric Power Systems in Commercial Buildings
4. National Fire Protection Association (NFPA):
   a. NFPA-70: The National Electrical Code
5. American National Standards Institute (ANSI):

a. C37.13: Low-Voltage AC Power Circuit Breakers used in Enclosures
b. C37.16: Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Protectors, Preferred Ratings

B. Equipment Dimensions

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where switchboards of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

C. Coordination

1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with engineering and structural features, equipment installed under other sections of the specifications and electrical equipment to insure access and so that clearance minimums are provided.

D. Provide 'test' switches where shown on the drawings to allow work on "energized" equipment within safe limits. Set trip characteristics per Arc-Fault study. When system is in 'test' mode, provide indicator light and label.

1.04 SUBMITTALS

A. Refer to the BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Product Data: Switchboards including, but not limited to, voltages, number of phases, frequencies, and short-circuit and continuous current ratings. Provide application data for main and branch circuit-breakers, sections, main buses, and basic insulation levels.

C. Shop Drawings: Layout drawings of switchboards showing accurately scaled basic equipment sections including auxiliary compartments, section components, and combination sections.

D. Wiring Diagrams: For switchboards showing connections to electrical power feeders and distribution branches. Differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed.

E. Closeout Submittals: As follows:

1. Record Drawings: Include in each set:
   a. Complete set of switchboard manufacturers' product data and shop drawings indicating all post bid revisions and field changes.

b. Schedule of each overcurrent protection device indicating unit ampere rating and trip rating.
c. Copy of the ground-fault system performance test as required by Article 230-95(c) of the NEC.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver switchboards and components properly packaged and mounted on pallets, or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for switchboards and components which protect equipment from damage. Install gravity measuring meters in containers which indicate whether container has been bumped or dropped. Return G-meters to manufacturer for re-use upon delivery of switchboards. Inspect equipment to ensure that no damage has occurred during shipment.

B. Store switchboard equipment in original packaging and protect from weather and construction traffic. Wherever possible, store indoors; where necessary to store outdoors, store above grade and enclose with watertight wrapping.

C. Handle switchboard equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove from site and replace damaged equipment with new.

1.06 SEQUENCING AND SCHEDULING

A. Schedule delivery of switchboard equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

B. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.

C. Coordinate with other electrical work including raceways, electrical boxes and fittings, and cabling/wiring work, as necessary to interface installation of switchboards with other work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton

2. Siemens
3. Square D

2.02 GENERAL

A. AC Dead-Front Distribution Switchboards: Provide factory-assembled, dead-front, metal-enclosed, self-supporting secondary power switchboards, of types, sizes, electrical ratings and characteristics indicated; consisting of vertical panel units, and containing circuit-breakers of quantities, ratings and types indicated. Provide copper main bus and connections to circuit-breaker branches of sufficient capacity to limit rated continuous current operating temperature rise of no greater than 65°C above average ambient temperature of 25°C; with main bus and tap connections silver-surfaced and bolted tightly according to manufacturer's torquing requirements for maximum conductivity. Brace bus for short-circuit stresses up to maximum interrupting capacity. Provide accessibility of line and load terminations from front of switchboard. Equip units with built-in lifting eyes and yokes; and provide vertical individual panel units, suitable for bolting together at project site. Construct switchboard units for the following environment:

1. Installation: Indoors, NEMA Type 1. Provide exterior NEMA 3R where shown.

B. Provide accessory and instrumentation small wiring, necessary fuse blocks and terminal blocks within the switchboard. Control components, such as control transformers, fuse blocks, relays, etc., shall be suitably marked for identification where mounted on the switchboard corresponding to appropriate designations on manufacturer's wiring diagrams. All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips. Provide wire markers at each end of all control wiring.

2.03 BUSSING

A. All bus bars shall be silver-plated copper with bolted connections at joints. The bus bars shall be of sufficient size to limit the temperature rise to 65°C rise based on UL tests, and rated to withstand mechanical forces exerted during short circuit conditions when directly connected to a power source having an available fault current as shown on the drawings. Provide full capacity neutral where a neutral is indicated on the drawings.

B. A ground bus rated a minimum of 25% of main bus ampacity shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard. An incoming ground lug shall be furnished. Other ground lugs for feeder circuits shall also be supplied as shown in the schedules on the drawings.

C. All hardware used on conductors shall be high-tensile strength and plated. All terminals shall be of the anti-turn solderless type suitable for CU or A1 cable of sizes indicated for 75°C cable.

2.04 CONSTRUCTION

A. Switchboards shown mounted against a wall shall be front accessible. All sections of the switchboard shall be 20" deep except service sections containing large ampacity main disconnects which may be deeper as required. All sections of the switchboard shall align so that the back of the complete structure may be placed flush against a wall i.e. rear aligned only.

B. Construction shall allow maintenance of incoming line terminations, main device connections and all main bus bolted connections to be performed without rear access. The feeder or branch devices shall be removable from the front and shall be panel mounted with the necessary device line and load connections front accessible. Provide lugs on all devices for cable sizes shown on drawings.

2.05 METERING

A. Where indicated on the drawings, provide a separate customer metering compartment with front hinged door and include the following:

1. Current transformers
2. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.
3. Indicating ammeter with ammeter switch indicating voltmeter with voltmeter switch and KWHR demand meter.

2.06 OVERCURRENT DEVICES - GENERAL

A. Main protective devices shall be fixed mounted molded case breaker with interrupting rating, frame and trip ratings as shown on the drawings. Provide drawout breakers where shown.

B. Group mounted feeder protective devices shall be molded case breaker type with frame and trip rating as shown on the drawings and have additional characteristics as specified.

C. Devices shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings. Provide electrically operated breakers for generators.

2.07 MOLDED CASE BREAKERS

A. Protective devices as shown shall be molded case circuit breakers providing complete circuit overcurrent protection by having inverse time and instantaneous tripping characteristics, and where applicable, be current limiting.

1. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip free. Automatic tripping of the breaker shall be clearly indicated by handle

position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.

2. Circuit breaker interrupting capacities shall be as indicated on the drawings or as specified hereinafter. Where applicable, circuit breakers shall be listed for series application.

B. Breakers 150 ampere and below shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 250 and 400 ampere frame shall be thermal-magnetic or solid-state trip, as applicable.

C. Breakers with 600 amperes frame and above shall be solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have trip rating plugs with ratings as indicated on the drawings. Rating plugs shall be interlocked so they are NOT interchangeable between frames and interlocked such that a breaker cannot be latched with the rating plug removed.

1. Trip units shall have adjustable short time setting with a fixed instantaneous override for circuit protection. Main breakers shall be provided with additional instantaneous and short delay trip time adjustment for increased system coordination.
2. Breakers shall have built-in test points for testing long delay, instantaneous and ground fault functions of the breaker by means of a 120 volt operated test kit. Provide one test kit capable of testing all breakers 600 ampere and above.
3. Where indicated on the drawings, provide built-in ground fault protection with adjustable pick-up rating not exceeding 1200 amperes; ground fault time delay shall be adjustable 0.1 to 0.5 seconds. Provide neutral ground fault current transformer for four wire systems.

D. Where indicated on the drawings, provide zero sequence ground fault protection system with necessary sensor, monitor, test panel, shunt trip and control power source for use with breakers indicated.

2.08 NAMEPLATES

A. Engraved nameplates shall be furnished for all main and feeder circuits including control fuses and also for all indicating lights and instruments. Nameplates shall give item designation and circuit number as well as frame size and appropriate trip rating. Furnish Master nameplate giving switchboard designation, voltage ampere rating, short circuit rating, manufacturer's name, general order number and item number. Refer to ELECTRICAL IDENTIFICATION section of this specification.

2.09 FINISH

A. All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchboard shall be ANSI 61 and use the manufacturer's standard process.

2.10 CONTROL POWER TRANSFORMERS

A. Control power transformers with primary and secondary protection shall be provided as indicated on the drawings or where required to operate ground fault systems, adequately sized for required burdens.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions under which switchboards and components are to be installed, and notify General Contractor in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the Installer.

3.02 INSTALLATION OF SWITCHBOARDS:

A. Install switchboards as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of NEC, NEMA's Stds Pub/No. PB 2.1, and NECA's "Standard of Installation".

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Stds 486 A and B, and the National Electrical Code.

3.03 FIELD QUALITY CONTROL

A. Refer to ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

3.04 ADJUSTING AND CLEANING

A. Adjust operating mechanisms for free mechanical movement.

B. Touch-up scratched or marred surfaces to match original finishes.

3.05 GROUNDING

A. Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL Std 486A to assure permanent and effective grounds.

3.06 FIELD QUALITY CONTROL

A. Subsequent to wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

DIVISION 26 – ELECTRICAL

262416 – PANELBOARDS

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. The work required under this section of the specifications consists of the furnishing, installation and connection of lighting and appliance panelboards and distribution type panelboards.

B. Panelboards designated as HDA, HDB, DA, DB, etc., or indicated on the drawings shall be distribution type panelboards. Those designated as HA, HB, A, B, etc., are lighting and appliance type panelboards.

C. Definitions: The term panelboard, as used in this specification or on the drawings, shall mean the complete assembly including the enclosure, bus work, trim hardware and circuit breaker or fused devices. The words panel and panelboard are used synonymously in these contract documents.

1.03 QUALITY ASSURANCE

A. Industry Referenced Standards. The following specifications and standards are incorporated into and become a part of this Specification by Reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 50: Cabinets and Boxes, Electrical
   b. No. 67: Panelboards
   c. No. 489: Molded Case Circuit Breakers and Circuit Breaker Enclosure
2. National Electrical Manufacturer's Association (NEMA) Publications:
   a. No. PB-1: Panelboards
   b. No. AB-3: Molded Case Circuit Breakers
3. National Fire Protection Association (NFPA):
   a. No. 70: National Electrical Code (NEC)

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.

1. Siemens
2. Eaton
3. Square D

C. Coordination: Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure panel access and insure that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to BASIC ELECTRICAL REQUIREMENTS for submittal requirements.

B. Manufacturers Product Data:

1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
   a. Circuit breakers
   b. Panelboards

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.

1. Include electrical characteristics and ratings for each panelboard with dimensions, mounting, bus material, voltage, ampere rating, mains, poles and wire connection, and any accessories. Indicate method of ground bus attachment to enclosure.
2. Include front elevation bussing diagram indicating each bussing circuit breaker position.
3. Provide a schedule indicating circuit breaker type, trip and size, poles, frame type, and interrupting capacity.

D. Record Drawings. Include in each set:

1. A complete set of panelboard manufacturers product data and shop drawings indicating all post bid revisions and field changes.
2. A copy of each panelboard directory incorporating all post bid revisions and field changes.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS REQUIREMENTS

A. Furnish all materials specified herein.

B. All panels and circuit breakers shall be UL listed and bear a UL label.

C. Panels shall be of the dead front safety type.

D. Provide panels complete with factory assembled circuit breakers connected to the bus bars in the positions shown on the panel schedules or bus diagrams as indicated on the drawings.

E. Number all panelboard circuits in the following sequence:

1. Circuits No. 1 and 2, Phase A; Circuits No. 3 and 4, Phase B; Circuits No. 5 and 6, Phase C. Connect two pole breakers to phase indicated on the drawings.

2.02 BUSSING AND INTERIORS

A. All bus bars shall be copper. Main lugs and main breakers shall be UL approved for copper or aluminum conductors and shall be of a size range for the conductors indicated on the drawings. Each panel shall contain an equipment grounding bus. Each lighting and appliance panelboard shall contain a full size insulated neutral bus. Where a distribution type panelboard is indicated on the drawings to have a neutral bus, the bus shall be insulated and full size, unless otherwise indicated on the drawings.

B. The neutral and ground busses shall have a sufficient number of lugs to singularly terminate each individual conductor requiring a connection.

C. The ground bus shall be factory brazed, riveted or installed on studs bolted to the panel enclosure or panel frame. The ground bus shall not be attached to the panel interior.

D. Where designated on panel schedule as "space", include all necessary bussing, device support and connections. Provide blank cover for each space.

2.03 ENCLOSURES

A. Panelboard width shall not be less than 20", nor more than 22" unless specific width is indicated on the drawings. Panelboard depth shall not exceed 5-3/4".

B. Distribution panelboard width shall not be less than 31" and the depth shall not exceed 14".

C. Review panelboard schedules and system one line diagram and provide panelboard gutters and bending space at terminals to conform to the National Electrical Code.

D. Provide concealed captive clamping devices, concealed hinges and lock for all flush mounted panels. Key all panels throughout project alike.

E. All surface mounted panels, except exterior rated panels, shall be provided with door-in-door hinged cover trims. Trims shall be secured by piano hinges to enclosure and secured closed by two trim clamps.

F. Provide a directory card, metal holder, and transparent cover permanently mounted on inside of doors.

G. Where indicated on the drawings or required for the environmental conditions, provide a NEMA 4X enclosure.

H. Provide mini-power center panels with integral main breaker, dry type transformer and panel where indicated on the drawings.

2.04 CIRCUIT BREAKERS

A. Interrupting rating of all circuit breakers in panelboards operating on 208Y/120 volt system shall have UL rating of not less than 10,000 RMS symmetrical amps at system voltage. Panelboards for use on 480Y/277 volt system shall contain circuit breakers with UL interrupting rating of not less than 14,000 RMS symmetrical amps at system voltage. Provide circuit breakers with higher interrupting capacity when indicated on the drawings.

B. Circuit breakers shall be provided with trip rating, poles and minimum interrupting rating as indicated on the drawings or specified herein.

C. Multi-pole breakers shall be common trip and common reset; tie handle connection between single pole breakers is not acceptable.

D. Branch circuit breakers in lighting and appliance panels shall be quick-make, quick-break, thermal magnetic type bolted to the bus. Circuit breakers in distribution type panelboards shall be bolted to the bus except, Square D I-line style plug in devices are acceptable.

E. Molded case circuit breakers shall have automatic, trip free, non-adjustable, inverse time, and instantaneous magnetic trips for 100 ampere frame or less. Magnetic trip shall be adjustable for breakers with 600 ampere frames and higher. Factory setting shall be HI, unless otherwise noted.

F. Provide the following special devices and accessories when indicated on the drawings, specified herein, or required by the NEC.

1. Ground fault interrupting circuit breaker (GFI).
2. Provide handle lock-off device to prevent manually turning off device without removal. Install on all circuit breakers indicated on the panel schedule.

2.05 SEPARATELY ENCLOSED MOLDED CASE CIRCUIT BREAKERS

A. Where separately enclosed molded case circuit breakers are shown on the drawings, provide circuit breakers in accordance with the applicable requirements of those specified for panelboards.

PART 3- EXECUTION

3.01 INSTALLATION

A. Mount panelboards with top circuit not more than 6'-6" above finished floor.

B. Lace and group conductors installed in panels with nylon tie straps. Only one conductor shall be installed under terminal of individual circuit breakers. Form and train conductors in panel enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug.

C. Do not splice conductors in panels. Where required, install junction box adjacent to panel and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the conductors and cables section of the specifications and do not exceed.

D. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
   b. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   c. Attach enclosure directly to masonry, concrete, or wood surfaces.
   d. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure or sheet rock walls.

E. Conductors not terminating in panelboard shall not extend through or enter panel enclosure.

F. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.

G. Provide in each panelboard with a typewritten circuit directory mounted under clear plastic in a metal directory frame on interior of panel door. Directory shall reflect any field changes or additions.

H. Install push-in knock-out closure plugs in any unused knock-out openings.

I. Identification

1. Panelboards and individually mounted circuit breakers shall be identified.
2. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.
3. Submit complete schedule with the shop drawings listing all nameplates and information contained thereon.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

C. Adjust and align panelboard interior and trim in accordance with manufacturers recommendations, and to eliminate gaps between the two.

3.03 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

END OF SECTION

DIVISION 26 – ELECTRICAL

SECTION 262419 - MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections apply to this Section.

1.02 SUMMARY

A. The work required under this section of the Specifications consists of the installation of all Motor Control Centers for use on systems 600 volts and below. All materials and devices which are an integral part of the Motor Control Center shall be provided under this section of the specifications.

B. Definition: Motor Control Centers are floor mounted assemblies of one or more enclosed vertical sections having a common horizontal power bus and primarily containing combination Motor Control Units. Units are mounted one above the other in the vertical sections, with power supplied to the individual units by vertical power busses. The words motor control units, starters, and motor controllers are used synonomously in these contract documents.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this Specification by reference.
   1. National Electrical Manufacturers Association (NEMA) Standards:
      a. ICS-1: General Standards for Industrial Control and Systems
      b. ICS-2: Industrial Control Devices, Controllers and Assemblies
      c. ICS-3: Industrial Systems
      d. ICS-4: Terminal Blocks for Industrial Control Equipment and Systems
      e. ICS-6: Enclosures for Industrial Controls and Systems
   2. Underwriters Laboratories, Inc. (UL) Publications:
      a. UL 198.4: Class R Fuses
      b. UL 508: Industrial Control Equipment
      c. UL 845: Standard for Motor Control Centers
   3. National Fire Protection Association (NFPA)
      a. NFPA 70: National Electrical Code
   4. American National Standards Institute (ANSI):

a. C97.1: Low Voltage Cartridge Fuses, 600 Volts or Less

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable.
1. Motor control centers and controllers:
a. Square D
b. Siemens
c. Cuttler Hammer
2. Fuses:
a. Gould-Shawmut
b. Buss
c. Littlefuse

C. Equipment Dimensions
1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where motor control centers of acceptable manufacturers listed exceed the maximum dimensions, products of such manufacturers shall not be acceptable.

D. Coordination
1. Review shop drawings submitted under this and other sections, as well as other divisions, to ensure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure access and so that clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to basic electrical requirements section for submittal requirements.

B. Manufacturer's Product Data:
1. Submit material specifications and installation data for products specified under Part 2 - Products to include:
a. Motor controllers
b. Motor control centers
c. Fuses

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings.
1. Include electrical characteristics and ratings for each motor control center with dimensions, mounting, bus material, voltage, bracing, ampere rating, mains, poles and wire connection, and any accessories.
2. Include bussing diagram indicating each bussing motor control unit, circuit breaker, or fused switch position.

3. Provide a schedule indicating motor control unit type, or trip and size, poles, frame type, fuse size and type, and interrupting capacity.
4. Identification designation schedule.

D. Record Drawings - Include in each set:
   1. A complete set of motor control center manufacturers product data and shop drawings indicating all post bid revisions and field changes.
   2. A schedule of each motor's actual full load nameplate rating and NEMA design with the selected overload heater catalog number and current range.

PART 2 - PRODUCTS

2.01 GENERAL

A. Furnish all materials specified herein.

B. Motor control center, motor control units, circuit breakers, and fused devices shall be UL listed and bear the UL label.

C. The type of enclosure shall be in accordance with NEMA standards for Type 1, gasketed construction. All enclosing sheet steel, wireways and unit doors shall be gasketed.

D. The motor control center shall be suitable for operation on a 480 3-phase, 3-wire 60 Hz system.

E. Motor control center wiring shall be NEMA Class I type B.

2.02 STRUCTURE ARRANGEMENT

A. Motor Control Center shall consist of free-standing, standardized vertical sections; each section shall have the following nominal dimensions: 90" H. x 21" W. x 16" D. Maximum overall dimensions, not to be exceeded, shall be as indicated on the drawings.

B. Each section shall contain continuous horizontal and vertical wireways. The horizontal wireway shall be located at the top and bottom of the section. Vertical wireways shall be provided adjacent to each unit. All wireways shall have provisions for cable support, shall be isolated from the bus bars and shall be accessible through hinged doors held closed by captive screws.

C. Adequate space for conduit and conductors entering the top or bottom, in accordance with the National Electrical Code, shall be provided without structural interference. Conductors shall be safely accessible without disrupting service.

D. Individual sections shall be assembled to form a totally enclosed deadfront, front accessible motor control center, as indicated on the drawings.

E. Motor control center design shall permit the future installation of matching vertical sections without the need for transition sections.

2.03 BUS ARRANGEMENT

A. Each vertical section shall contain a continuous three-phase bus, rated as shown on the drawings. Vertical busses shall be connected to the main horizontal bus.

B. A continuous, three-phase, main horizontal bus, rated as shown on the drawings, shall be provided for the distribution of power to the vertical busses. The main bus shall be located in the upper part of the structure.

C. Each vertical section shall contain a neutral bus connected to a main horizontal neutral bus, all rated at 50% of the main bus rating.

D. All non-current-carrying parts of the control center shall be grounded through the use of a continuous horizontal ground bus connected to vertical ground busses in each section. Ground bus rating shall not be less than 25% of main bus rating. Bus design shall include feature that for any plug-on unit the ground bus stab shall make contact with the ground bus before the power bus contact is made.

E. All busses shall be tin-plated copper, rated for a 50 degrees C. temperature rise above a 40 degrees C ambient. The minimum bus bracing, in RMS - symmetrical-amperes, shall be as shown on the drawings. Busbars shall be isolated and insulated with polyester boards front and back.

F. A front accessible main lug compartment shall be provided for incoming line termination. Lugs shall be suitable for terminating the size and quantity of conductors as indicated. The compartment shall be located in the unit space shown on the drawings and shall have a hinged door held closed by captive screws. Door shall have provisions for a padlock.

2.04 UNIT CONSTRUCTION

A. Combination magnetic starters shall be installed in removable units constructed in basic heights of 12" or multiples thereof. Each unit shall be isolated from others on structure. Connection to vertical bus for NEMA size five across the line starters and smaller shall be made with draw out stab type connection. Each plug-in type unit shall have a provision for positive horizontal and vertical alignment. Provisions shall also be included for positive ground connections through plug-in facilities. Each magnetic starter shall contain an overload relay in each phase, three in all. Each unit shall contain separable control terminal blocks and separable power terminal blocks to permit removal of unit without disturbing control wiring.

B. Magnetic starters shall be the combination type with molded case circuit breakers. UL listed interrupting rating of molded case circuit breaker shall not be less than indicated on the drawings at system voltage.

C. Provide reduced voltage solid state starters where shown. Each starter to have ramp up and ramp down adjustable controls. Coordinate rating of RVSS with motor provided. Provide HOA switch, red 'RUN' pilot lamp, blue 'OVERLOAD' pilot lamp and 2 NO/NC contacts.

D. Where VFD's are shown to be in motor control center, provide as required in section 262923.

E. Individual starter doors and individual overcurrent device doors shall be interlocked to prevent door from being opened until switch is in "OFF" position. However, a "cheater screw" or other inconspicuous means shall be provided to permit access to energized starter, by authorized personnel. An interlock contact shall be provided within the starter to open control circuit to magnetic starter when device handle is in the open position. A door activated interlock switch is not acceptable.

F. Each magnetic starter shall be provided with HOA switch, as indicated on the drawings. Where no device is indicated on the drawings, provide an HOA switch for any motors automatically controlled or an ON-OFF switch for those specified to be manually controlled. Provide each magnetic starter with a "RUN" and an "OVERLOAD" pilot lamp. Control devices shall be of oil tight construction and shall be mounted on a removable panel on the unit door. Identify each control device with a metal tag or plastic laminated label.

G. Overload heaters shall be electronic adjustable type shall be selected in accordance with full load rating of motors actually furnished. Relay switching mechanism shall be single pole, double throw with normally open position connected to operate a door mounted, oil tight blue pilot lamp to indicate starter has tripped on overload.

H. Control voltage for magnetic starters shall be 120 volts obtained from a individual control power transformers in each magnetic starter. Each control power transformer shall be fused.

I. Provide contacts in magnetic starters to provide interlocking control sequence of operation specified under Division 23. Provide two normally open and one normally closed spare auxiliary contacts in each starter.

J. Starter sizes are based on design conditions using horsepower ratings of motors indicated on drawings. If motors actually furnished have horsepower ratings other than those indicated, motor starters and feeders shall be adjusted in accordance with the rated horsepower at no additional cost to the Owner.

K. Provide, where indicated, molded case circuit breakers for feeder protection. All circuit breakers shall have UL interrupting rating of not less indicated on the drawings, at system voltage. Provide current limiting breakers as required.

2.05 AUXILIARY EQUIPMENT

A. Identification:
   1. The motor control center, each magnetic starter, each feeder protective device, and each auxiliary equipment item shall be provided with an engraved plastic nameplate approximately 1" x 3" permanently attached to the unit exterior door with self-tapping screws. Refer to ELECTRICAL IDENTIFICATION section.
   2. Refer to the basic electrical requirements section of these specifications for nameplate requirements.
   3. Submit complete schedule with the shop drawings listing all nameplates and information thereon.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install motor control center on 4" high concrete pad, the horizontal dimensions of which shall exceed the base dimensions of the motor control center by 3" on all sides.

B. Control and power circuits shall terminate in respective section in which starter is located.

C. Lace and group conductors installed in motor control center with nylon tie straps. Only one conductor shall be installed under each terminal. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eighth inch from terminal lug.

D. Do not splice conductors in motor control center. Where required, installed junction box adjacent to enclosure and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the wires and cables section section of the specifications and do not exceed.

E. Conductors not terminating in motor control center section or unit shall not extend through or enter the section or unit.

F. Maintain conductor phase color code requirement described in the wires and cables section of the specifications.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

C. Select and install overload heaters based on the full load current of the motor actually installed. All heaters in a starter shall be of the same size.

3.03 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.04 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specification.

B. Contractor shall verify in the field that all factory-made connections and terminations are torqued to manufacturer's recommended tolerances.

END OF SECTION

DIVISION 26 – ELECTRICAL

262726 – WIRING DEVICES

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. The work included under this section of the specifications consists of the installation of wiring devices, i.e. switches and receptacles and device plates. All materials shall be provided under this section of the specifications.

B. Select devices from lists of acceptable devices contained in this section of the specifications.

C. The catalog numbers listed herein for switches and receptacles are for items with brown finish. Notwithstanding catalog numbers, the switches and receptacles provided on this project shall have ivory finish unless otherwise indicated. All special purpose receptacles shall be provided in black finish.

1.03 QUALITY ASSURANCE

A. NEMA WD-1 General Purpose Wiring

B. NEMA WD-5 Specific Purpose Wiring Devices

PART 2 - PRODUCTS

2.01 SWITCHES

A. Select switches from the following:

1. Single pole, 20 amp 277 volt switch: Arrow Hart 1991, Hubbell 1221, Leviton 53521, Pass & Seymour 20AC1.
2. Threeway, 20 amp 277 volt switch: Arrow Hart 1993, Hubbell 1223, Leviton 53523, Pass & Seymour 20AC3.
3. Four way, 20 amp 277 volt switch: Arrow Hart 1994, Hubbell 1224, Leviton 53524, Pass & Seymour 20AC4.
4. Weatherproof, 20 amp 277 volt switch: Arrow Hart 2991-2881G, Hubbell 1281-1750, Pass & Seymour 22515-4515.

2.02 RECEPTACLES

A. Select receptacles from those listed herein. Designation in parenthesis is NEMA configuration required.

1. 15 amp, 125 volt grounded duplex receptacle (5-15R): Arrow Hart 5262, Hubbell 5262, Leviton 5262, Pass & Seymour 5262.
2. 20 amp, 125 volt grounded duplex receptacle (5-20R): Arrow Hart 5739, Hubbell 5362, Leviton 5362.
3. Ground Fault Interrupter (GFI) 15 amp, 125 volt duplex receptacle: Leviton 6194, Arrow Hart 1591, Hubbell GFTWRST82, Pass & Seymour 1591-F.
4. Ground Fault Interrupter (GFI), 15 amp 125 volt duplex receptacle, through feed type: Arrow Hart 1591-F, Leviton 6399, Pass & Seymour 1591-F, Hubbell GFTWRST83.
5. Transient Voltage Surge Suppression (TVSS) receptacles shall comply with ANSI/IEEE C62.41 and LILI449 (July 1987) for categories A and B. Devices shall provide RFI and EMI noise filtration of not less than a 7:1 reduction. Devices shall suppress transients in each of 3 modes: Line-to-neutral, line-to-ground, and neutral-to-ground. Devices shall be provided with an LED for positive indication of failure of protective circuitry or audible alarm. Products complying with this specification manufactured by Arrow Hart, Hubbell, Leviton, or Pass and Seymour are acceptable.

2.03 DEVICE PLATES

A. Device plates shall be one piece single or multi-gang type selected to match the device or combination of devices. Device plates for flush mounted devices shall be type 302 stainless steel unless indicated otherwise.

1. Device plates for use with devices flush mounted in exposed masonry construction shall be jumbo type. Device plates for surface mounted devices shall be for use with the type of outlet box in which the device is mounted. All devices installed in areas exposed to the weather and where indicated on the drawings shall be provided with a weatherproof device plate.
2. Where engraved device plates are indicated on the drawings or specified in Division 16, engraving shall be done by the device plate manufacturer. All lettering shall be 1/8" high and shall be black unless other contrasting color is specified.

PART 3- EXECUTION

3.01 GENERAL INSTALLATION

A. The mounting height of devices are indicated in the legend on the drawings and is intended to mean the bottom of the device above the finished floor unless otherwise indicated on the drawings. Where finished walls are exposed concrete block, brick or tile, the height shall be adjusted to allow outlet box for device to be mounted at a joint.

B. Review Engineering Drawings for any device requiring specific location. Install receptacles above countertops with major axis horizontal above the backsplash.

C. Mount all devices within outlet boxes to allow device plates to be in contact with wall on all sides. Align devices with major axis of device parallel to adjacent predominate building feature, i.e., doorframes or countertops.

D. Install wall switches on the strike side of doors.

END OF SECTION

DIVISION 26 – ELECTRICAL

262816 – CIRCUIT AND MOTOR DISCONNECTS

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 covers disconnect switches for electrical equipment, 600V and below, and fuses mounted in the disconnect devices.

B. Furnish and install disconnect switches for any of the following conditions:

1. Where indicated on the drawings.
2. For all motors located out-of-sight of its motor controller.
3. For water heaters.
4. For electrical unit heaters.
5. Where required by the National Electrical Code.

1.03 QUALITY ASSURANCE

A. Referenced Industry Standard: The following specifications and standards are incorporated into and become a part of this Specification by reference.

1. Underwriters' Laboratories, Inc. (UL) Publications:
   a. No. 98: Enclosed Switches
   b. No. 198.2: High-Interrupting Capacity Fuses, Current Limiting Type
   c. No. 198.4: Class R fuses
2. National Fire Protection Association (NFPA) Publications:
   a. No. 70: National Electrical Code (NEC)
3. National Electrical Manufacturers Association (NEMA) Publications:
   a. No. KS 1: Enclosed Switches

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:

1. Siemens
2. Eaton
3. Square D

C. Coordination: Coordinate installations with architectural and structural features, equipment installed under other sections of the specifications and electrical equipment to insure disconnect switch access and insure that clearance minimums are provided.

PART 2 - PRODUCTS

2.01 GENERAL MATERIAL REQUIREMENTS

A. Furnish all materials specified herein.

B. All disconnects and fuses shall be UL listed and bear a UL label.

C. Fuses shall be heavy duty, type HD horsepower rated as required for motor load served.

D. Switches shall be 600 volt rated, except for use in system below 240 volt, when they may be 250 volt rated. Switches shall be heavy duty rated. General duty switches are not acceptable.

E. Furnish a solid neutral for each switch being installed in a circuit which includes a neutral conductor.

F. Furnish an equipment grounding conductor lug bonded to the switch enclosure.

G. Disconnect switches shall be non-fusible safety switch, unless fused type is specified or indicated on the drawings, with the number of poles required to disconnect all ungrounded conductors serving equipment.

H. Enclosure shall be NEMA Type One in all interior dry locations and shall be NEMA Type 4X stainless steel in all damp, wet, or exterior locations, unless other type is indicated on the drawings or specified herein.

2.02 PRODUCT/MATERIAL DESCRIPTION

A. Switching mechanism shall be quick-make, quick-break type.

B. Where non-fused disconnect switches are indicated on the drawings or specified for use as disconnects, they shall be the non-fused type.

C. Switches shall have the following features:

1. Provide line terminal shields in all switches.
2. Each switch shall have provisions for padlocking in the "OFF" position.
3. Each switch shall have door interlocks to prevent door from being opened when switch is in closed position. Provide inconspicuous means to defeat interlock mechanism.
4. Provide permanent nameplate indicating switch rating in voltage, amperes and horsepower.

5. Arch chute for each pole.
6. Provide auxillary contacts (break-first/make-last) for VFD driven motors.

D. Disconnect switches for three phase motors rated two horsepower and above shall be three pole nonfusible type rated as indicated on the drawings. Disconnect switches for three phase motors rated below two horsepower shall be three pole manual motor starter switches without overload protection. Disconnect for single phase motors shall be single or two pole horsepower rated switches without overload protection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Locate disconnect switches to maintain line of sight and to provide working clearance and full accessibility as required by the National Electrical Code.

B. Unless indicated otherwise on the drawings, locate disconnects adjacent to equipment served.

C. Lace and group conductors installed in disconnect with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond 1/8" from terminal lug.

D. Mounting and Support

1. Enclosure shall be secured to structure by a minimum of four (4) fastening devices. A 1.5" minimum diameter round washer shall be used between head of screw or bolt and enclosure.
2. Mounting
   a. Enclosures shall be mounted where indicated on the drawings or specified herein. Support from the structure with fastening device specified.
   b. Attach enclosure directly to masonry, concrete, or wood surfaces.
   c. Mount enclosure on metal channel (strut), which is connected to structure with fastening device specified, for installations on steel structure, sheet metal equipment enclosure, or sheet rock walls.
   d. Where enclosure is not indicated on a wall or structure, construct a metal channel (strut) free standing frame secured to floor, pad, or other appropriate building structure. Refer to the detail on the drawing for frame installation and construction information.
   e. Mount switch with handle between 36" and 60" above floor or grade, unless otherwise indicated on the drawings.

E. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to disconnect and splice or tap conductors in box. Refer to number of conductors in a conduit limitation defined in the WIRES AND CABLES section of the specifications and do not exceed.

F. Conductors not terminating in disconnect shall not extend through or enter disconnect enclosure.

G. Install push-in knock-out closure plugs in any unused knock-out openings (NEMA1). Provide Hoffman Hole-Seal in NEMA 4X switches.

H. Identification

1. Disconnect switches shall be identified.
2. Refer to the ELECTRICAL IDENTIFICATION section of the specifications for identification requirements.

3.02 CLEANING AND ADJUSTMENT

A. After completion, clean the interior and exterior of dirt, paint and construction debris.

B. Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

END OF SECTION

DIVISION 26 – ELECTRICAL

262913 – MOTOR CONTROLLERS

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. The work required under this section of the specifications consists of the installation of motor controllers for all integral or fractional horsepower motors not controlled by magnetic starters installed in motor control center or by magnetic starters provided as an integral component of a specific piece of equipment. Provide all material under this section of the specifications.

1.03 QUALITY ASSURANCE

A. ANSI/NEMA Standards Publication ICS 1 - General Standards for Industrial Control and Systems.

B. ANSI/NEMA Standards Publication ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. UL 508 Standards for Industrial Control Devices, Controllers and Assemblies - Industrial Control Equipment.

1.04 ACCEPTABLE MANUFACTURERS

A. The products of Siemens, Square D, or Eaton conforming to these specifications are acceptable.

PART 2- PRODUCTS

2.01 MAGNETIC STARTERS

A. Magnetic starters shall be across-the-line circuit breaker combination type non-fusible disconnect combination type when remotely located from circuit breaker in panel or switchboard; otherwise magnetic starters shall be non-combination type. Where circuit breaker type are used, UL interrupting rating of circuit breaker shall not be less than the rating of the overcurrent device immediately upstream.

B. Magnetic starters shall be NEMA size one unless other size is shown on the drawings or unless larger size is required by actual motor controlled. Enclosures shall be NEMA one unless otherwise shown on the drawings or specified in this section of the specifications. Starters shall be for operation at the voltage and phase arrangement indicated.

C. Each magnetic starter shall have solid state overload protectin for each phase leg. Control voltage shall be 120 volts provided from a control power transformer built into starter. Provide fuse for control coil. Provide Hand-Off-Automatic switch, in cover of starter unless otherwise indicated on the drawings. Interlocks shall be provided to provide control sequence indicated on the drawings. Interlock contact shall be provided circuit breaker of combination magnetic starters to disconnect control circuit when circuit breaker is in "off" position.

D. Operating handle of disconnect device in combination starters shall be interlocked with door to prevent opening door when starter is energized; however an inconspicuous means shall be provided to defeat this interlock. Operating handle must have provisions for not less than two padlocks.

E. Overload relay shall be solid state type and shall be selected from actual nameplate rating of motor furnished.

2.02 MANUAL MOTOR STARTERS

A. Manual motor starter shall be manually operated, trip free switching device with motor running protection overload elements in each ungrounded conductor of the motor circuit. Overload protection shall be melting alloy or bi-metallic manual reset type.

B. Manual starters installed in finished spaces shall be provided in flush mounted enclosures. Those exposed to the weather shall be provided with NEMA 4X enclosure. All other enclosures shall be NEMA one type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Secure wall mounted magnetic starters to mounting surface with wood screws on wood, toggle bolts on hollow masonry, and lead shields on solid masonry.

B. Manual motor starters shall be provided for all fractional horsepower, single phase motors rated 1/6 HP or larger.

C. Overload element shall be selected in accordance with full load nameplate rating of motor actually served. A heater schedule shall be provided on inside cover all motor starters.

3.02 IDENTIFICATION

A. Refer to the ELECTRICAL IDENTIFICATION section of these specifications for identification requirements.

3.03 FIELD QUALITY CONTROL

A. Refer to the ELECTRICAL EQUIPMENT ACCEPTANCE TESTING section of this specifiction.

END OF SECTION

DIVISION 26 - ELECTRICAL

SECTION 262923 – VARIABLE FREQUENCY DRIVE UNITS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. General

1. The CONTRACTOR shall provide variable frequency drive (VFD) units, complete and operable, as indicated in accordance with the Contract Documents.
2. It is the intent of this Section to require complete, reliable, and fully tested variable frequency drive systems suitable for attended or unattended operation.
3. This section applies to VFD's in motor control centers and free standing type.

B. The requirements of Section 26 00 00 – ELECTRICAL WORK, GENERAL, apply to the WORK of this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to standardize appearance, operation, maintenance, spare parts, and manufacturer's services.
2. This requirement, however, does not relieve the contractor of overall responsibility for the work.

D. Coordination

1. Equipment provided under this Section shall operate the electric motor driver and the driven equipment as indicated under other equipment specification Sections.
2. The CONTRACTOR'S attention is specifically directed to the need for proper coordination of the WORK under this Section and the equipment specifications.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of shop drawings, product data and samples, except that Shop Drawing information for the drives shall be coordinated with the information for the driven equipment.

B. Shop Drawings: Include the following information:

1. Equipment Information
    a. Name of drive manufacturer
    b. Type and model
    c. Assembly drawing and nomenclature
    d. Maximum heat dissipation capacity in kw
2. Conduit entrance provisions
3. Circuit breaker type, frames, and settings
4. Information related to relays, timers, pilot devices, control transformer va, and fuse sizes, including catalog cuts

5. Ladder Diagram
   a. Submit the system schematic ladder diagram and interconnection diagrams.
   b. The schematic ladder diagram shall include remote devices.
   c. The ladder diagram shall incorporate the control logic on the corresponding elementary schematic as indicated.
   d. Submittals with drawings not meeting this requirement will not be reviewed further and will be returned to the contractor stamped "REJECTED."
6. Factory test data certifying compliance of similar equipment from the same manufacturer with requirements of this Section.
7. Where shown on drawings, provide bypass RVSS starters.

C. The Technical Manual shall include the following documentation:

1. Manufacturer's 2-year warranty
2. Field test report
3. Programming procedure and program settings

D. Spare Parts List

1. Submit information for parts required by this Section plus any other spare parts recommended by the controller manufacturer.

PART 2 -- PRODUCTS

2.01 GENERAL

A. The contractor shall provide variable frequency drives where shown on the drawings. Coordinate rating of VFD with equipment provided.

2.02 EQUIPMENT

A. General

1. The power supply shall be an adjustable frequency inverter designed to convert incoming 3-phase, 480-volt, 60-Hertz power to a DC voltage and then to adjustable frequency AC by use of a 3-phase inverter.
2. Current-source inverters will not be accepted.
3. Inverters shall be sized to match the KVA and inrush characteristics of the motors actually provided.
4. The contractor shall be responsible for matching the controller to the load (variable torque or constant torque) as well as the speed and current of the actual motor being controlled.
5. The contractor shall provide "clean power" 18-pulse VFD's or 6 pulse VFD's integrated with AP Broadband Filters for VFDs that are operating motors greater than or equal to 50 HP. Alternatively, Active Front End VFD designs with 3-level type active rectification will be acceptable, given the harmonic THDi contributed at the drive input terminals is no more than 5%.

B. Inverter

1. The inverter shall be of a voltage-source design, producing a pulse-width-modulated type output.
2. All VFDs shall be 18 pulse drive to conform to IEEE 519.
3. Motor Coordination
   a. Inverters shall be capable of operating with 460-volt, 3-phase, 60-Hertz, squirrel-cage, high-efficiency, inverter duty, induction motors.
   b. Inverters shall be capable of operating motors over the range of 50-100 percent of base speed without derating or requiring any motor modifications.
   c. Provide proper size VFD's for high torque applications.
4. Inverters shall be capable of delivering the nameplate horsepower exclusive of service factor without the need for mandatory thermostats or feedback tachometers.
5. The VFD shall vary both the AC voltage and frequency simultaneously in order to operate the motor at required speeds.

C. The minimum VFD inverter efficiency shall be 95 percent at 100 percent speed and load, and 85 percent efficiency at 50 percent speed and load.

D. Power Outage

1. The VFD shall shut down in an orderly manner when a power outage occurs on one or more phases.
2. Upon restoration of power and a START signal, the motor shall restart and run at the speed corresponding to the current process input signal.

E. The VFD shall be provided with the following features:

1. Inrush current adjustment between 50 and 110 percent of motor full load current (factory set at 100 percent)
2. Overload capability at 110 percent for 60 seconds for variable torque loads and 150 percent for constant torque loads.
3. Adjustable acceleration and deceleration
4. Input signal of 4 - 20 ma from process
5. Output speed signal of 4 - 20 ma; signals other than 4 - 20 mA will not be accepted.
6. Upon loss of input signal, the VFD shall operate at a preset speed.
7. A minimum of 2 selectable frequency jump points in order to avoid critical resonance frequency of the driven system.
8. Additional devices and functions as indicated
9. Ethernet communications to transmit VFD data to/from a plant PLC-based control system.
10. For VFD's serving submersible motors, provide leak and high temp interface devices. Where motors are provided with internal temp monitoring, provide thermal modules as required.

F. The VFD shall be provided with, as a minimum, the following protection features:

1. Input line protection with metal oxide varistor (MOV) and RC network
2. Protection against single phasing
3. Instantaneous overcurrent protection
4. Electronic overcurrent protection

5. Ground fault protection
6. Overtemperature protection for electronics
7. Protection against internal faults
8. Ability to start into rotating motor (forward or reverse rotation)
9. Additional protection and control as indicated and as required by the motor and driven equipment

G. The VFD shall be designed and constructed to satisfactorily operate within the following service conditions.

1. Elevation
    a. Elevation to 3300 feet
    b. For elevation greater than 3300 feet, the VFD shall be derated in accordance with the manufacturer's recommendation
2. Ambient Temperature: 0 to 40 degrees C
3. Humidity: 0 to 95 percent, non-condensing
4. AC Line-Voltage Variation: plus 10 percent to minus 10 percent
5. AC Line-Frequency Variation: plus and minus 2 Hertz

H. Electrical equipment provided in addition to the adjustable frequency inverter for each drive shall include:

1. 2-1/2-percent (minimum) line reactors integral to the drive enclosure.
2. Provide a dV/dT filter device at the motor or VFD output per the manufacturer's recommendation for all motors over 100ft from VFD and as shown on the drawings. Submit documentation demonstrating where such devices are required, along with mounting and cabling requirements.
3. Fused 480-to-120-volt control transformer to provide system control power for the logic and pilot lamps.
4. Provide an input circuit breaker.

I. Inverter Signal Circuits

1. The inverter signal circuits shall be isolated from the power circuits and shall be designed to accept an isolated 4-20 mA signal in the automatic mode of operation.
2. The inverter shall follow the setting of a remote or local potentiometer control while in the manual mode.
3. Refer to the Elementary Schematic indicated on the Drawings for speed control and START/STOP methods.
4. Access to set-up and protective adjustments shall be protected by key-lockout.
5. The following operator monitoring and control devices for the inverter shall be provided on the face of the VFD enclosure, either as discrete devices or as part of a multi-function microprocessor-based keypad access device:
    a. AUTO/HAND selection from a remote logic relay or switch
    b. While in AUTO, the inverter shall operate from the remote 4-20 mA input, where applicable, and while in HAND control shall operate from a local or remote manually operated speed potentiometer; speed pot ratings shall be coordinated with the supplier of the Local Control Station.
    c. Speed indicator calibrated in percent speed

d. Inverter fault trip pilot light and output alarm contacts
e. Trip reset pushbutton
f. RUN and OFF indicating lights
g. Provide amber pilot lights for internal safeties with manual reset pushbuttons.
h. Provide other controls and readouts normally furnished as standard equipment, or as otherwise indicated on the Elementary Schematics indicated on the Drawings.

J. Properly identified screw type terminal boards shall be provided for interconnection to remote controls and instrumentation

K. Pilot devices, control relays, time delay relays, elapsed time meters, and indicators provided as a part of the VFD equipment package. For each VFD, provide HOA switch with additional contacts. Provide all auxiliary contacts required per plant controls requirements.

L. All VFDs shall be provided with a Modbus TCP/IP ethernet connection for interface to Emerson SCADA. Connection shall be natively without a getaway.

2.03 SPARE PARTS

A. The CONTRACTOR shall furnish the spare parts listed below, suitably packaged and labeled with the corresponding equipment number.

B. Modified Parts

1. At any time prior to Substantial Completion, the CONTRACTOR shall notify the ENGINEER in writing about any manufacturer's modification of spare part numbers, interchangeabilities, or model changes.
2. If the ENGINEER determines that the modified parts no longer apply to the equipment provided, the CONTRACTOR shall furnish other applicable parts as part of the WORK.

C. The following spare parts shall be furnished:

1. Provide one set of spare power fuses of each form, voltage, and current rating.
2. Provide 10 spare control and power fuses of each type and rating.
3. Provide 10 panel lamps of each type (form, voltage, and current rating).
4. Provide one set of any special tools required for maintenance of the VFD units

2.04 MANUFACTURERS

A. Schneider Electric/Square D

B. Eaton

C. ABB

D. For other manufacturers to be considered, provide verification that VFD can interface with Emerson SCADA system per paragraph 2.02.L.

PART 3 -- EXECUTION

3.01 MANUFACTURER'S SERVICES

A. General

1. An authorized service representative of the manufacturer shall be present at the Site to furnish the services listed below.

B. The authorized service representative shall supervise the following and shall certify that the equipment and controls have been properly installed, aligned, and readied for operation:

1. Installation of the equipment
2. Inspection, checking, and adjusting the equipment
3. Startup and field testing for proper operation
4. Performing field adjustments such that the equipment installation and operation comply with requirements
5. Document all settings of VFD's and RVSS in record drawings

C. Instruction of OWNER's Personnel

1. The authorized representative shall instruct the OWNER's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with test equipment.
2. The instruction shall be specific to the VFD models provided.
3. Training shall be scheduled a minimum of 3 weeks in advance of the first session.
4. Training shall include individual sessions for 4 shifts of plant personnel.
5. Proposed training materials shall be submitted for review, and comments shall be incorporated.
6. Training materials shall remain with the trainees.
7. The OWNER may videotape the training for later use with the OWNER's personnel.

3.02 INSTALLATION

A. Conduit stub-ups for interconnected cables and remote cables shall be located and terminated in accordance with the drive manufacturer's recommendations.

B. Programming

1. The CONTRACTOR shall perform programming of drive parameters required for proper operation of the VFDs included in this project.
2. Submit records of programming data in the equipment Technical Manual, including setup and protective settings.

3.03 FIELD TESTING

A. Testing, checkout, and startup of the VFD equipment in the field shall be performed under the technical direction of the manufacturer's service engineer.

B. Under no circumstances shall any portion of the drive system be energized without authorization from the manufacturer's representative.

C. Verify proper operation of control logic in every mode of control.

D. Document all settings of all values in record documents.

END OF SECTION

DIVISION 26 – ELECTRICAL

263213 – ENGINE DRIVEN EMERGENCY POWER SUPPLY SYSTEM

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. The work required under this section of the specifications consists of the installation of the complete Engine Driven Emergency Power Supply System. All materials and devices which are an integral part of this system shall be provided under this section of the specifications.

B. Definition: The Emergency Power Supply System (EPSS) shall consist of one or more engine driven generator sets, each of which contains an engine directly coupled to an electric generator, together with the necessary switchgear, controls, accessories, transfer devices, and fuel supply to provide electric power for the duration of any failure of the normal power supply.

1. Automatic Transfer Switch (ATS): An automatic transfer switch is self-acting equipment for transferring one or more load conductor connections from one power source to another.

C. For this project the contractor shall provide two 2000kW/2500kVA diesel engine-generator sets with permanent magnet excitation using simple paralleling, a Level 2 sound-attenuated 150mph wind rated aluminum housing, 8,000 gallon capacity double wall sub-base tank for each generator, a 4000A 4-pole closed transition isolation/bypass automatic transfer switch.

Each generator shall extend power to free-standing outdoor switchgear. This switchgear to be provided by the generator manufacturer.

Each generator to include provisions to allow communications with the plant Emerson SCADA system using an ethernet connection. Communications between emergency power system and SCADA system shall use modbus TCP/IP ethernet protocol natively without gateway. Coordinate with Emerson system and provide interface as required.

D. The existing Cummins 500 KW diesel generator located at the influent pump station shall be modified to add a new Gateway to provide a Modbus connection to the plant SCADA system. Use Alan Bradley Compac Logic.

1.03 QUALITY ASSURANCE

A. The following specifications and standards are incorporated into and become a part of this specification by reference.

1. National Fire Protection Association (NFPA):
   a. NFPA-37 Combustion Engines
   b. NFPA-70 National Electrical Code
   c. NFPA-110 Emergency and Stand-By Power Systems
2. Diesel Engine Manufacturers Association (DEMA) Standard: Standard Practices for low and medium speed stationary diesel and gas engines.
3. Electrical Generating Systems Association (EGSA) Standards:
   a. EGSA CEP2 Codes for Emergency Power by States and Major Cities
   b. EGSA GTD3 Glossary of Standard Industry Terminology and Definitions
   c. EGSA ECB1 Performance Standard for Engine Cranking Batteries
   d. EGSA TSS1 Performance Standard for Transfer Switches for use with Engine Generator Sets
   e. EGSA BCES1 Performance Standard for Battery Chargers
   f. EGSA ICAE1 Performance Standard for Electric Generator Set Instrument Control and Auxiliary Equipment
4. Institute of Electrical and Electronics Engineers (IEEE) Standards:
   a. IEEE 446 IEEE Recommended Practices for Emergency and Standby Power Systems
   b. IEEE 472 Voltage Surge Withstand Capabilities
5. National Electric Manufacturers Association (NEMA) Standards:
   a. MG-1 Motors and Generators
   b. ICS1-109 Test and Test Procedures for Automatic Transfer Switches
   c. ICS2-447 A.C. Automatic Transfer Switch
6. Underwriters Laboratories Inc. (UL) Publications:
   a. UL 1008 Automatic and Non-Automatic Transfer Switches
7. American National Standards Institute (ANSI):
   a. C37.90a Voltage Surge Withstand Capability

B. Acceptable Manufacturers: Products of the following manufacturers, which comply with these specifications, are acceptable:

1. Engine Driven Generator Sets:
   a. Cummins – No substitutions. Contact John Carper, Cummins South, (912) 210-3383 for information. See paragraph 1.02C for communications requirements with SCADA.
2. Transfer Switches and Generator Switchgear:
   a. Cummins – No Substitutions.
3. Sub-Base Fuel Tanks:
   a. Pryco
   b. Simplex

C. Equipment Dimensions:

1. Dimensions indicated on the drawings are maximum allowable and shall not be exceeded. Where equipment of acceptable manufacturers listed exceeds the maximum dimensions, products of such manufacturers shall not be acceptable.

D. Coordination:

1. Review shop drawings submitted under this and other sections, as well as other divisions, to insure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications, and electrical equipment to insure access and to insure clearance minimums are provided.

1.04 SUBMITTALS

A. Refer to the SHOP DRAWINGS, PRODUCT DATA AND SAMPLES Section for required procedures.

B. Manufacturer's Product Data:

1. Submit material specifications and installations data for products specified under Part 2 - Products to include:
   a. Engine driven generator sets
   b. Transfer switches
   c. Sub-base fuel tanks
   d. Swtichgear
   e. Gateways

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract drawings. Submittals containing less than the information listed below will be rejected.

1. Shop drawings for the engine driven generator sets shall contain not less than the information listed as follows:
   a. Certification that the engine driven generator set(s) furnished will serve electrical loads indicated including motor starting loads with type(s) of starting indicated. Submit generator loading program with actual load information with shop drawings.
   b. Continuous and stand-by rating of engine driven generator set(s) including voltage and phase.
   c. Frequency and voltage regulation with maximum instantaneous voltage dip and time of recovery to stable operation.
   d. Output voltage adjustment range in percentage of rated plant voltage.
   e. Alternator type and method of connection to prime mover.
   f. Components contained in alternator instrument panel.
   g. Rating of engine at operating speed, engine cycle and number of cylinders.
   h. Type of engine lubrication system and verification of components specified.

i. Type of engine governor.
j. Components contained in engine instrument panel.
k. Fuel consumption at rated load.
l. Starting batteries including ampere hour rating.
m. Verification that all accessories specified are to be provided. This includes tank with capacity indicated, cold weather starting aid with rating and voltage indicated, exhaust system with muffler type indicated, and outdoor housing with verification of space available within housing for batteries.
n. Line and machinery constants of the generator furnished.

2. Shop drawings for the transfer switch shall contain not less than the information listed as follows:
   a. List of accessories contained in the control panel.
   b. Withstand rating in RMS symmetrical amperes.

D. Quality and Service:

1. All materials and parts of the EPSS shall be new and unused. Each component shall be of current manufacture from a firm regularly engaged in the production of such equipment. Units and components offered under these specifications shall be covered by the manufacturer's parts and labor warranty for a minimum of five years from date of Owner acceptance of the project on a new machine, a copy of which shall be included in the shop drawings submittal.
2. Submittals will be accepted only on engine driven generator sets and transfer switches which can be properly maintained and serviced without requiring the Owner to stock spare parts or wait longer than twenty-four hours for service. Submittals shall include the nearest location of permanent parts outlet from which parts may be obtained and written assurance that trained service personnel will be available on twenty-four hour's notice. Units with service centers more than 50 miles from project site will not be accepted.

E. Record Drawings

1. Include in each set three sets of operating, maintenance, and parts manuals covering all components for the EPSS. Each supplier shall provide instructions to the Owner in operation and maintenance of his equipment, both in written form and with on-site personnel for a minimum of eight hours.

PART 2 - PRODUCTS

2.01 ENGINE DRIVEN EMERGENCY POWER SUPPLY (EPS)

A. Engine

1. The engine driven emergency power supply (EPS) shall be two internal combustion diesel driven prime movers using simple parallelling. The generator sets shall have the following characteristics:
   a. 2-2000 KW Capacity
   b. 2-2500 KVA Capacity

   c. 480Y/277V
   d. 60Hz
   e. 0.8 Power Factor
   f. 3 Phase
   g. 4-Wire

2. Refer to drawings for loads which are to be powered from the emergency power system. One generator shall be sized to starter and run all loads listed under Phase I. The emergency power system shall be sized to start and run all loads in Phase 2 if the generators are connected in parallel.

   Coordinate with SCADA and Kubota to provide load starting to match steps shown.

3. The rated net horsepower of the engine at the generator synchronous speed, with all accessories, shall not be less than that required to product the KW specified in paragraph 1 above. The horsepower rating shall take into account generator efficiency and all accessory losses such as fans, battery charger, etc. The generator set shall be capable of producing the specified KW (without overload) for the duration of the power outage, under the following ambient conditions:
   a. Altitude: 50 feet above mean sea level.
   b. Air temperature at engine intake: 104 degrees F.
   c. Humidity Range: 5 - 95%.
4. Included with the shop drawing submittal shall be the manufacturer's estimate of supply fuel and oil consumption for the engine. The engine shall have an oil filter with replaceable elements, and a lube oil cooler.
5. The engine shall be equipped with a suitable governor (engine speed control) to maintain frequency within limit specified below by controlling engine and generator speed. Provide controls to allow generator speed to be adjusted for forced closed transition operation.
   a. Type: Isochronos
   b. Stability: 1/2% maximum steady state frequency variation at any constant load from no load to full load.
   c. Regulation: 5% maximum frequency deviation between no-load steady state and full load steady state.
   d. Transient: 2 seconds maximum recovery time for maximum motor start.
6. The engine shall be electric start, provided with a solenoid energized motor with either positive engagement or clutch drive to the engine.
7. The engine starting batteries shall be sealed lead-acid recombination type. Batteries shall be rack mounted inside the weatherproof plant housing to minimize the distance from the batteries to the starter. Provide battery straps and battery heaters.
8. A float type battery charger, compatible with the batteries selected, shall be furnished at the engine which shall maintain the starting batteries at full charge. The charging system shall permit charging from either the normal or the

emergency power source. Provide battery straps and battery heater per NFPA110.

9. It shall have an equalize rate and a float rate charging system. An ammeter and voltmeter shall indicate the charge rate and the circuit shall be protected by either fuses or circuit breakers. The charger or charging circuit shall be so designed that it will not be damaged during the engine cranking cycle, for example, by a current limiting charger or a crank disconnect relay. It shall also be capable of recharging a discharged battery in 12 hours while carrying normal loads. The charger shall be equipped with alarm relays as required for remote annunciation equipment.
10. The engine shall be liquid cooled. The type of liquid cooling system shall be unit mounted radiator - consideration shall be given for air temperature rise across the engine in addition to ambient. Minimum capacity shall be rated for 104°F. minimum engine ambient temperature plus air temperature rise across the engine.
    a. Provide an electric heater, thermostatically controlled, in the engine coolant system as a cold weather starting aid. Heater shall be for operation on 120 or 240 volt single phase A.C. and shall be permanently connected to a circuit from the generator panel. Heater shall maintain 70°F. to 90°F.
    b. Provide isolation valves or quick connect couplings for jacket water heater.
11. Air Supply/Exhaust System
    a. Cleaner: An air cleaner and silencer shall be furnished, located and mounted as recommended by the engine manufacturer.
    b. Exhaust: An exhaust system of suitable size, configuration, and material in accordance with engine manufacturer's recommendations shall connect the exhaust outlet of the engine to a silencer. The type of silencer shall meet the requirements of engine manufacturers and shall be critical. The silencer shall be located inside of the outdoor enclosure.
    c. The exhaust system including silencer shall be of such size that back pressure on the system will not exceed the back pressure permitted by the engine manufacturer's recommendation. A flexible connection shall be mounted at the engine exhaust outlet and the discharge end shall be protected against entry of precipitation. Provide vertical discharge with rain cap. Piping and silencer within reach of personnel or with 8'-0" of finished floor or grade shall be protected by screening and shall be insulated with two inches of calcium silicate insulation with aluminum jacket. All exhaust piping shall be gas tight.
12. The engine instrument panel shall be mounted at the engine and shall contain the following:
    a. Oil pressure gauge to indicate lubricating oil pressure.
    b. Temperature gauge to indicate cooling medium temperature.
    c. Hour meter to indicate total actual running time.
    d. Battery charging meter to indicate satisfactory performance of battery charging means.

e. Other instruments as recommended by the manufacturer for proper maintenance.
f. Manual stop/start controls: All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified.

B. Generator

1. The generator shall be an engine-driven single or two bearings type, synchronous, brushless, conforming to applicable standards. It shall be connected to the engine flywheel by means of a flexible type coupling for single bearing generators and elastic coupling for two bearing generators.
2. The generator shall be rated for 40°C. ambient. Class of insulation shall be NEMA Class F. The voltage regulation shall be plus or minus 2% from no load to full load with plus or minus 5% speed change and a 15°C. rise in ambient. The generator voltage dip from no load to full load shall not exceed 16%.
3. The generator shall be capable of sustaining at least 250% of rated current for at least ten (10) seconds under a three phase symmetrical short by inherent design or by the addition of an optional current boost system. A line sensing protection system shall be furnished which protects the generator from damage due to its own high current capability. This shall not trip within the ten seconds specified above to allow selective tripping of downstream fuses or circuit breakers under a fault condition.
4. Provide 120 volt condensation heater in generator windings.
5. The generator shall be the Permanent Magnet type generator.

C. Voltage Regulation

1. The generator shall be equipped with a volts-per-hertz type voltage regulator to maintain voltage within limits specified below:
   a. Stability: 2% maximum voltage variation at any constant load from no load to full load.
   b. Regulation: 4% maximum voltage deviation between no load steady state and full load steady state.
   c. Transient: 20% voltage dip or overshoot on one-step application or removal of 0.8 power factor full load.

D. Start and Stop Controls

1. Automatic starting and stopping controls shall be furnished to start the engine automatically when the normal electrical power fails or falls below specific limits and to stop the engine automatically after the normal power supply resumes. The signal for starting or stopping the engine shall be sensed through an auxiliary contact in the automatic transfer switch. The controls shall be capable of operating at 50% of normal DC system supplied voltage.

2. The cranking cycle shall be initiated by manual start, loss of normal power at any transfer switch, clock exerciser, or the manually operated test switch at each ATS.
3. Crank control and the time delay relays shall provide a minimum of 4 crank attempts of at least 7 seconds each, separated by appropriate rest periods. A sensing device shall automatically disconnect the starting circuit when the engine has started. If the engine has not started at the completion of the starting program, the overcrank signal shall indicate. The engine starting controls shall be locked out and no further starting attempts shall take place until the overcranking device has been manually reset.
4. A selector switch shall be incorporated in the automatic engine start and stop controls. It shall include an "off" position that prevents manual or automatic starting of the engine; a "manual" position that permits the engine to be started manually by the pushbutton on the control cabinet and run unloaded; an "automatic" position that readies the system for automatic start or stop on demand or the automatic load transfer switches or of the programmed exerciser.
5. A remote weatherproof manual stop station for each generator similar to a break-glass station shall be provided on switchgear enclosure exterior and shall be tied into the engine controls to stop the engine when activated. Provide laminated plastic label with 1/4" minimum engraved letters to read "EMERGENCY GENERATOR SHUTDOWN". Background to be red and core to be white.

E. Instrumentation

1. Local and remote engine control and safety panel shall be provided for each generator, containing the following:
   a. Automatic remote start capability.
   b. "Manual-Off-Auto" switch.
   c. Controls to shut down and lock out the prime mover under the following conditions: failure to start after specified cranking time, overspeed, low lubricating oil pressure, high engine temperature, or operation of remote manual stop station.
   d. Battery powered individual alarm indication to annunciate visually at the control and safety panel the occurrence of any condition itemized below; contacts or circuits for a common audible alarm signaling locally the occurrence of any itemized conditions listed below. Test switch shall be provided to test the operation of all lamps.
      1) Indicator Function, Level 1 (At Battery Voltage):

		Local and Remote Control Panels Mounted Visual Indication	Shutdown of EPS	Audible
a)	Overcrank	X	X	X
b)	Low Water Temp. < 70°F (21°C)	X		X
c)	High Engine Temp. Pre-alarm	X		X
d)	High Engine Temp.	X	X	X
e)	Low Lube Oil Pressure Pre-alarm	X		X
f)	Low Lube Oil Pressure	X	X	X
g)	Overspeed	X	X	X
h)	Low Fuel Main Tank	X		X
i)	EPS Supplying Load	X		
j)	Control Switch Not In Auto Pos.	X		X
k)	Battery Charger Malfunctioning	X		X
l)	Low Voltage in Battery	X		X
m)	Lamp Test	X		X
n)	Contacts for Local & Remote			
o)	Common Alarm	X		X
p)	Audible Alarm Silencing Switch			
q)	Fuel in Containment Basin	X		X
r)	Remote Emergency Stop	X	X	X

2) Controls to shutdown the prime mover upon removal of initiating signal or manual emergency shutdown.
3) A.C. voltmeter with selector switch off position and positions for phase to phase and phase to neutral.
4) A.C. ammeter with selector switch with positions for each phase.
5) Frequency meter -- digital electronic type.
6) Voltage adjusting rheostat to allow plus or minus 5% voltage adjustment.

7) Manual reset circuit breaker.
8) Water temperature gauge.
9) Manual stop/start control.
10) Elapsed time meter.
11) Panel lights.
12) Indicator lights for signals from engine instrument panel.
13) Light to indicate switch has been left in the "off" position.

2. All instruments, controls, and indicating lights shall be properly identified. All wires shall be individually identified and must agree with the wiring diagram provided. All wiring shall be harnessed or flexibly enclosed. Terminals on all terminal blocks shall be individually identified. All instrumentation must be isolated from engine generator set vibration.
3. Provide gateway as specified for each generator to communicate with SCADA system. Coordinate all parameters required by owner.

F. Enclosures and Connections:

1. All electrical enclosures, i.e, terminal cabinets, wireways, circuit breaker enclosures, etc., shall be of adequate size to provide minimum bending radius as required by the NEC for the size conductor actually terminated within or passing through the enclosure.
2. All factory provided enclosures shall have gasketing and finish appropriate for the environment in which the unit is to be mounted. All wiring, wiring harness, etc., shall be protected from the elements, such as direct sunlight, moisture, etc. or shall be UL listed for direct exposure to the applicable elements. Include written documentation of the above with the shop drawing submittal.

G. Provide flexible fuel connections at supply at return piping. Flexible hoses shall be steel reinforced type. Provide solenoid valve in series with gate valve in supply line. Solenoid valve shall be powered from generator batteries and shall be open only when generator is running.

H. Provide service lights, switch and receptacle within the generator enclosure. Connect to generator panel. Provide battery pack with two heads inside each enclosure.

I. For each generator, provide a mini-power panel consisting of a pre-assembled 60A/2P main breaker, single phase, 480 volts, 15 kVA single phase 480-230/115V dry type transformer with secondary panel consisting of an 80A/2P main breaker and at least 12-20A/1P breakers and 2 pole breakers as required.

2.02 GENERATOR SWITCHGEAR

A. Switchgear Ratings:

1. The paralleling/distribution power switchgear shall be configured as shown on the contract drawings and rated for operation at voltage and current levels as

shown on the contract drawings. It shall contain devices and equipment as shown on the drawings, in addition to meeting the requirements of this section.

2. The generator switchgear shall allow the emergency power system for operate in parallel using "single paralleling" controls. Loads shall be evenly distributed when both generators are on line provide interface controls to SCADA system as shown on the drawings.

B. Construction:

1. Each section of the paralleling system shall be listed and labeled under the requirements of UL 891, including all covers, barriers, and supports. Breakers shall be isolated from individual control sections by metal or insulating barriers.
2. The system bus shall be silver plated copper with bolted joints for all three phases, with a full neutral, and a 1/4 x 2-inch ground bus extending through all sections. Bus shall be rated as required for proper operation with source and load currents, shall be braced for peak symmetrical amperage available from all generator sets plus motor contributions and shall be rated at 100,000 amps RMS, minimum.
3. The framework and all other sheet metal components of the system shall be primed with a rust-inhibiting primer and finished with two coats of satin finish ANSI 61 gray enamel. Switchgear shall be for exterior locations.
4. The switchgear shall be UL891 listed and labeled.
5. Switchgear wiring shall be composed of UL listed, 105-degree centigrade rated material, with all wiring labeled at each end.
6. Paralleling circuit breakers shall be rated for operation at the system voltage, with continuous current rating of as shown on the drawings. Breakers shall be electrically operated for both opening and closing and shall close within 5 electrical cycles from command by the paralleling controls.
7. Current transformers as required for proper system operation and metering as described herein shall be provided. Current ratios and relay and metering accuracy as required for function of the system. Transformers provided shall have a mechanical rating equal to the momentary rating of the circuit breakers, and insulated for the full voltage rating
8. Note space available and access requirements for the paralleling equipment and provide equipment that will fit into the space allowed. Note that switchgear equipment is front access only.
9. All door mounted control components shall be industrial type oil-tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.
10. AC control circuits in the switchboard shall be protected with properly sized fuses in safety fuse blocks, with visible fuse blown indication for each fuse. Potential transformers shall be protected on line and load side.
11. All CT installations shall include shorting type terminal blocks.

C. Distribution Equipment:

1. Provide feeder distribution breakers of the number and size as shown on the project drawings.
2. The breakers shall be manually operated, and of the same manufacturer as the paralleling breakers.
3. Generator breakers to be electrically operated.
4. For each main breaker provide test switch with indicator light to set tripping characteristics to lower arc fault rating to a safe level.

D. Control Equipment Construction

1. Note space available and access requirements for the paralleling equipment and provide equipment that will fit into the space allowed.
2. Each section of the paralleling control system shall be listed and labeled under the requirements of UL 891, including all covers, barriers, and supports. Individual control sections shall be isolated from each other by metal or insulating barriers.
3. All wiring shall be UL listed 105-degree C, 600 volt rated, and sized as required. Each wire, device or function shall be suitably identified by silk-screen or similar permanent identification.
4. The framework and all other sheet metal components of the system shall be primed with a rust-inhibiting primer and finished with two coats of satin finish ANSI 61 gray enamel.
5. All door mounted control components shall be industrial type oil-tight devices with contact ratings a minimum of twice the maximum circuit ampacity they are controlling. Toggle switches and other light duty control devices are not acceptable. Indicator lamps shall be high intensity LED type devices. Indicator lamp condition (on or off) shall be easily visible in bright room lighting conditions.
6. AC control circuits in the switchboard shall be protected with properly sized fuses in safety fuse blocks, with visible fuse blown indication for each fuse. Potential transformers shall be protected on line and load side.
7. All CT installations shall include shorting type terminal blocks.
8. All field control interconnecting wiring shall be sized as specified by system manufacturer (wiring not designated by the system manufacturer shall be minimum 14 AWG copper). All control interconnect wiring shall be stranded.

E. System Control Power

1. Control power for the paralleling system shall be derived from the generator set 24VDC starting batteries. A solid state, no break "best battery" selector system shall be provided so that control voltage is available as long as any battery bank in the system is available, and that all battery banks are isolated to prevent the failure of one battery from disabling the entire system. Generator set governing, voltage regulation, load sharing, synchronizing, protection, and control

equipment shall be capable of proper operation with battery voltage levels down to 8VDC.

2. Paralleling breaker control power shall be derived from the generator set for charging, opening, and closing the breakers. Breaker open circuit shall be provided from a DC source on each generator set.

F. Outdoor Enclosures:

1. The paralleling/distribution switchgear and controls shall be provided in a UL-listed non-walk-in style NEMA 3R outdoor enclosure.

G. Paralleling Controls. Provide a paralleling control panel for each generator set in the emergency/standby power system. The paralleling control functions may be integrated with the generator set control functions (with duplicate functions eliminated) and mounted on the generator set. Each paralleling control panel shall contain the components and devices as described in this section.

1. Operator Panel. Each paralleling control panel shall be provided with a panel to allow the operator to view the status and control operation of the specific generator set being paralleled. The operator panel shall be provided with the following features and capabilities.
   a. 1% accuracy generator set AC output instruments; Ammeter, Voltmeter, Frequency Meter, Wattmeter, KW-hour meter, Power Factor Meter. Selector switches to allow viewing of voltage and current for each phase shall be provided. For 3-phase/4-wire systems the voltmeter shall indicate line to line and line to neutral conditions. Voltmeter, ammeter, frequency meter, kW meter and power factor meter shall have both analog and digital displays. Switches and/or other provisions shall be included to allow reading of bus voltage and frequency from this metering set.
   b. Synchroscope and "generator set synchronized" indication. Indication may be synchronizing lamps, LED indication, or other provisions, but must be located on the paralleling control panel, adjacent to the paralleling breaker control switches.
   c. Running Time Meter, Start Counter. These devices shall display total running time and number of generator set starts, as well as the same functions since last reset.
   d. Generator Set Mode Selector Switch: Switch shall provide run (manual operation), off, and automatic functions for control of the generator set. Run/manual mode causes the generator set to immediately start and accelerate to rated speed and voltage, but paralleling breaker doe not automatically close. Off mode prevents generator set from starting, or immediately shuts down the generator set if it is running. Auto mode allows genset starting from a remote-control system.
   e. Breaker open/close switch with breaker status indicating lamps. The switch shall be interlocked with the control system such that breaker closure is not possible unless the mode select switch is in the run position and the generator set is synchronized with the system bus.

f. Control Reset push-button switch with indicating lamp. Lamp shall flash to indicate that generator set is locked out due to a fault condition.
g. Lamp test push-button switch. Operation of this switch shall cause all lamps on the panel to be simultaneously tested.
h. The control panel shall be provided with a set of DC-powered lamps with a switch to allow viewing of all functions on the front panel when other lighting systems are not available.
i. Emergency Stop switch. The emergency stop switch shall be a red, mushroom head switch which maintains its position until manually reset. The switch shall be provided with a lock-out/tag-out provision.
j. Precision voltage and frequency adjust raise/lower switches. Switches shall allow the generator set frequency and voltage to be adjusted plus or minus 5% when the generator set is operating independently of the system bus. Voltage and frequency adjustment switches shall be located adjacent to the generator set and bus metering, breaker control switches, synchroscope and manual paralleling panel, for ease of use by the operator. Voltage and frequency adjustments through these switches shall not impact on the load sharing control system.
k. Alarm and status indicating panel to indicate the following conditions, along with all engine alarm functions from the engine ECM:

Function	Lamp Color	Shutdown Unit
Low DC Voltage	Amber	
High DC Voltage	Amber	
Weak Battery	Amber	
Fail to Sync	Amber	
Low Oil Pressure Alarm	Amber	
Low Fuel - daytank	Amber	
High Engine Temp Alarm	Amber	
Overcurrent Alarm	Amber	
Breaker Failure	Red	*
Breaker Tripped	Red	*
Not in Auto	Red	*
High Engine Temp	Red	*
Low Oil Pressure	Red	*
Overcurrent	Red	*
Short Circuit	Red	*
Loss of Excitation	Red	*

Reverse Power	Red	*
Overcrank	Red	*
Overspeed	Red	*
Under Frequency	Red	
Under Voltage	Red	*
Over Voltage	Red	*
Phase Rotation	Red	*
Low Coolant Level	Red	*
Automatic	Green	
Generator Running	Green	
Breaker Open	Green	
Breaker Closed	Red	
Demand Mode Standby	Green	
Timing for Start	Green	
Timing for Shutdown	Green	

2. Provide auxiliary contacts as shown on the drawings for input to SCADA.
3. Internal Controls. The following internal control components or functions shall be provided for each generator set in the system.
   a. Generator set start contacts rated 10 amps at 32 VDC. A redundant network-based starting system shall also be provided.
   b. Equipment shall be provided to monitor the generator set as it is starting and verify that it has reached at least 90% of nominal voltage and frequency before closing to the bus. The equipment provided shall positively prevent out-of-phase paralleling if two or more engine-generator sets reach operating conditions simultaneously by providing a lockout signal to disable breaker closure for generator set(s) in the system which have not been selected to be the first units to close to the bus. Controls to recognize the failure of the first breaker signaled to close and allow system operation to proceed in spite of this failure shall also be provided (breaker failure alarm). Systems using dead bus relay schemes without a disable signal to positively prevent out-of-phase paralleling shall not be acceptable under this specification. System shall include an independent backup to automatically operate in the event that the primary system fails.
   c. Controls shall be provided to verify generator set and bus phase rotation match prior to closing the paralleling breaker.
   d. Provide a first start sensing system to prevent simultaneous closure of two generator sets to the system bus on a black start condition.

e. Synchronizer to electronically adjust the engine fuel rate and alternator excitation to match the voltage, frequency and phase angle of the bus. Synchronizer shall maintain the engine-generator voltage within 1% of bus voltage and phase angle within 20 electrical degrees of the bus for 0.5 seconds before circuit breaker closing. The synchronizer shall be operational in a range of -40% to plus 10% of nominal frequency and voltage. Each generator set shall have its own synchronizer; systems using a switching scheme to utilize a single system synchronizer will not be approved. Synchronizers and systems which utilize a motor driven pot for control of AC voltage during the synchronizing process will not be accepted. The system shall be provided with a fail to synchronize time delay that is adjustable from 10-120 seconds. Control logic for fail to synchronize function shall allow field configuration of function for either alarm or shutdown of the generator set on failure condition.
f. Controls shall include a permissive (sync check) function, to be used with "generator synchronized" indicator during manual paralleling, to prevent accidental closure of the breaker with the generator set out of phase with the bus. Provisions to allow manual closure of the first generator set to a de-energized bus shall be included.
g. Electronic isochronous kW load sharing control to control the engine fuel rate to provide isochronous load sharing when the generator set is paralleled. The control system shall allow sharing of real kW load between all generator sets in the system to within 1% of equal levels, without introduction of frequency droop into the system. The isochronous load sharing system and engine governor shall be a coordinated system of a single manufacturer.
h. Electronic kVAR load sharing control to operate the alternator excitation system while the generator set is paralleled. The control system shall allow sharing of reactive load between all generator sets in the system to within 1% of equal levels, without introduction of voltage droop into the system. The control system shall include all equipment required for VAR load sharing with an infinite bus in either a constant VAR or constant power factor mode for future application flexibility. (Mode and adjustments selectable by the operator)
i. Controls shall include three phase sensing reverse power equipment, to prevent sustained reverse power flow into the generator set. When the reverse power condition exceeds 5% of the generator set kW for more than 3 seconds, the paralleling circuit breaker shall be tripped open and the generator shut down.
j. Electronic alternator overcurrent alarm and shutdown protection. This protection is required in addition to the overcurrent trip on the paralleling breaker and shall sense current flow at the generator set output terminals. The overcurrent alarm shall be indicated when the load current on the generator set is more than 110% of rated current for more than 60 seconds.

The overcurrent shutdown shall be matched to the thermal damage curve of the generator set and shall not have an instantaneous function.

k. Electronic alternator short circuit protection. This protection is in addition to the overcurrent trip on the paralleling breaker. The short circuit shall occur when the load current on the generator set is more than 175% of rated current and an aggregate time/current calculation indicates that the system is approaching the thermal damage point of the alternator. The equipment used shall not have an instantaneous function.
l. Provide overcurrent and short circuit protection for the feeder connecting the generator set to the paralleling switchgear. This protection may be integrated with alternator protection but must be positively coordinated to prevent tripping of the paralleling breaker prior to the operation of the alternator protective equipment.
m. Controls shall be provided to sense a reverse kVAR condition to the alternator while paralleled to the system bus. The protection shall be adjusted to operate at a value that is 10% below the maximum reverse kVAR that can be supported by the alternator provided. A reactive capability curve shall be submitted to verify the setting that is required.
n. Controls shall be provided to shut down generator set and initiate alarm when the generator set is at less than 85% of nominal voltage for more than 15 seconds, more than 110% of nominal voltage for more than 10 seconds, or more than 130% of nominal.
o. Cooldown time delay, adjustable: 0-600 seconds. The control panel shall indicate the time remaining before shutdown.
p. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for reliable system operation, as described herein under "SYSTEM OPERATION".

H. System Control. Provide system controls to manage the operation of the system to prevent overloading of the system bus on a black start condition or due to overload of the bus or shutdown of a generator set. The control system shall contain the components and functions described in this section.

1. Internal Control Components. The following internal controls shall be provided for system operation:
   a. Load pick-up output contacts, rated 10 A at 600 VAC (3 contacts per level). The load pickup contacts shall operate based on the number of generator sets available and connected to the bus.
   b. The load pickup contacts shall be interconnected with designated transfer switches to prevent connection of the designated transfer switches to the generator bus until sufficient capacity is available to serve the load.
   c. Load shed output contacts, rated 10 A at 600 VAC.
   d. The load shed contacts shall be operated based on system overload or bus under frequency. On indication of system overload or under frequency, designated transfer switches shall switch to a neutral position. The switches shall automatically reconnect to the generator bus if the under-frequency

condition is cleared, and to the utility source if it recovers before the under-frequency condition is cleared.

2. Provide all other components required, such as properly sized current transformers, transducers, terminal blocks, etc., for reliable system operation.

I. Loss Of Normal Power:

1. System is given signal to start by receipt of start signal from automatic transfer switches or other remote device. On receipt of this signal, all generator sets automatically and independently start, accelerate to rated frequency and build up to rated voltage. The first start system monitors this process, and on finding a generator set at 90% of rated voltage and frequency, automatically disables all other units from closing to the bus, and closes the ready unit to the bus. At this time the first priority loads close to the bus.
2. The priority (load add) controls prevent overloading of the system bus by providing control signals to delay operation of designated system loads until sufficient generating capacity is available on the bus.
3. After the first unit is closed to the bus, the control of the remaining units is switched to the synchronizer in each generator paralleling control, which causes the generator set to synchronize with the system bus, and then close to it at the proper time.
4. As each unit closes to the bus, the unit assumes it's proportional share of the total load on the bus, and the control system will automatically add loads to the generator bus by operating specified priority control devices.

J. Failure Of A Unit To Start Or Synchronize:

1. If a unit fails to start, after the fail to start time delay (in the generator set control) has expired, the unit will be shut down, and an alarm will sound. The priority control will prevent the lowest priority loads from being added to the system without manual intervention.
2. If a unit fails to synchronize, after a preset time delay, an alarm will sound, but the unit will continue to attempt to synchronize until signaled to stop by manual operation of the control switches on the generator set.

K. Bus Overload:

1. If a bus overload occurs for any reason, a load shed signal will be generated to initiate load shedding in the system.
2. Loads that are shed due to overload shall require manual reset via the operator interface panel.

L. Return of Normal Power

1. When all of the system start signals are removed from the generator sets, the system will begin a retransfer process.
2. The system shall sequentially transfer back to the utility by operating each transfer device sequentially.

3. When all loads have been transferred back to the utility, the generator set paralleling breakers shall all open, and the generator sets shall operate at no load for a cooldown period. When the cooldown period has been completed, the generator sets shall shut down.
4. If a system start signal is received during the cooldown period, one generator set shall immediately close to the system bus and all other units shall synchronize to it, as described in "Loss of Normal Power" above.

M. System Testing

1. Test with Load Mode:
    a. The system shall allow the generator sets to be tested by transfer of the system loads to the generator sets.
    b. Sequence of operation in this mode shall be similar to that described for a power failure condition.
2. Generator Set Exercise (Test) Without Load Mode
    a. The system shall allow testing of the generator sets at no load. In this operation mode the generator sets will start, build up to rated speed and voltage, synchronize and close to the generator bus, but system loads shall not automatically transfer to the generator system. If a power failure occurs during a test period, loads shall immediately close into the system on a priority basis.

N. Factory Testing. The system manufacturer shall perform an operational test on each major component of the paralleling system (including generator sets, paralleling controls, and power switchgear) prior to shipping from the factory. A certified test report shall be provided, included in the operator's manuals, and permanently retained by the system manufacturer.

2.03 TRANSFER SWITCH(ES)

A. Transfer switch(es) shall be rated at not less than as indicated on the drawings at rated voltage. Transfer switch(es) shall be rated and marked for total system load.

B. Transfer switch(es) serving three phase four wire loads shall be four pole. Provide closed transition, bypass isolation type. Provide timed intermediate position type if closed transition is not active.

C. Transfer switch(es) shall be the automatic type with power contact assemblies. Transfer switches shall be U.L. listed and labeled 1008.

D. Transfer switch(es) shall be floor mounted in a NEMA 1 painted steel enclosure. Enclosure shall have hinged door with three point latching and provisions for pad locking.

E. Operation shall be inherently double-throw whereby all contacts move simultaneously. Electrical spacing shall be equal to or exceed those listed in Table

15.1 of UL-1008. Only those main contact structures specifically designed for transfer switch service shall be acceptable. An overload or short circuit shall not cause the switch to go to a neutral position. A manual operating handle shall be provided. All main contacts shall be silver alloy type protected by arc quenchers and, for switches rated 600 amps and larger, by arching contacts. Operating transfer time shall be 1/15 second or less on switches rated below 600 amps. The transfer sequence shall be "Closed Transition". Provide controls to adjust the generator's frequency to force parallel to utility on transfer.

F. All switch and contacts, coils, springs and control elements shall be removable from the front of the transfer switch without removal of the switch panel from the enclosure and without disconnecting power conductors or drive linkages. Control and sensing relays shall be continuous duty industrial type with minimum contact rating of ten amps.

G. Transfer switch shall be rated to withstand in RMS symmetrical amperes not less than the available symmetrical RMS amperes when protected by the circuit protective device on the line side of the transfer switch. Withstand rating of switch shall be based on switch contacts not welding under fault conditions.

H. Transfer switches shall be U.L. listed and labeled for service entrance. Transfer switches shall be furnished with an insulated neutral, bonding jumper and a ground bar bolted to the transfer switch enclosure.

I. The control panel for each automatic transfer switch shall contain the following accessories and Features.

1. ATS Control Panel
    a. The automatic transfer switch(es) shall provide a control panel mounted into the front of the switch. This control panel shall display source condition information including:
    b. AC voltage for each phase of normal and emergency source. All three phases shall be displayed on a single screen for viewing of voltage balance and on 4-wire systems, line to neutral voltage shall be displayed for each phase.
    c. Frequency of each source.
    d. Display source status including indication whether source is/is not connected.
2. The ATS control panel shall allow the operator to make adjustments to and/or set nominal voltage and frequency of the ATS, frequency sensor operation set points, time clock functions, and load sequence functions. The operator may also enable/disable ATS functions, set up exercise and load test operation conditions, normal system time delays for transfer, time delay to start, stop, transfer and retransfer. These parameters may only be accessed following password input from the authorized operator.

3. The display shall include real time clock data, including date, time (HH:MM:SS) and log total operating hours for the control system.
4. The display shall include a service history for the ATS and a fault history on the ATS.
5. Adjustable 0.5 to 6 second time delay on starting of EPS to override momentary power dips and interruptions of the normal services. Time delay shall be factory set at 1 second.
6. Time delay on transfer to emergency adjustable from 0 to 60 seconds, factory set at 0 seconds.
7. Test switch on enclosure door to simulate failure of the normal power source. ATS shall transfer load to the EPS.
8. Push button to bypass time delay on re-transfer to normal.
9. Close differential voltage sensing shall be provided on all phases of the normal power supply. The pickup voltage shall be adjustable from 85% to 100% of nominal and the dropout voltage shall be adjustable from 75% to 98% of the pickup value. The transfer to emergency will be initiated upon reduction of normal source to 85% of nominal voltage and re-transfer to normal shall occur when normal source restores to 95% of nominals.
10. Independent single phase voltage and frequency sensing of the emergency source. The pickup voltage shall be adjustable from 85% to 100% of nominal. Pickup frequency shall be adjustable from 90% to 100% of nominal. Transfer to emergency upon normal source failure when emergency source voltage is 90% or more of nominal and frequency is 95% or more of nominal.
11. A time delay on re-transfer to normal source. The time delay shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from 0 to 25 minutes and factory set at 15 minutes.
12. An unloaded running time delay for emergency generator cool-down, factory set at 5 minutes.
13. Provide adjustable timed intermediate position in both directions when not in closed transition mode.
14. Pilot light for indicating switch in normal position (include fuses and auxiliary contact).
15. Pilot light for indicating switch in emergency position (include fuses and auxiliary contact).
16. An exerciser for exercising standby power plant on a weekly basis shall be provided in the transfer switch. Exerciser shall be set to exercise standby plant for one half hour per week under load. Time of plant exercise shall be set in field. Exerciser timer shall have reserve power back-up, either by battery or spring-wound clock, to ride through power outages to the switch.
17. Auxiliary contact (gold plated) which closes when normal source fails. (Closed after override delay of 0.5 to 6 seconds).
18. Auxiliary contact (gold plated) which opens when normal source fails. (Opens after override delay of 0.5 to 6 seconds).

19. Auxiliary contacts on same shaft as main contacts (closed on normal.)
20. Auxiliary contacts on same shaft as main contacts (closed on emergency).
21. Provide 'ready to transfer' signal in both directions.

J. Bypass Isolation Switch

1. The bypass isolation switch(es) shall have the same specification requirements as the automatic transfer switch portion of this specification except as described below:
   a. The automatic transfer and bypass-isolation switch shall be provided to manually permit convenient electrical bypass and isolation of the automatic transfer switch. Bypass of the load to either the normal or emergency power source with complete isolation of the ATS shall be possible regardless of the status of the ATS. The bypass-isolation switch shall permit proper operation by one person through the movement of a maximum of two handles at a common dead front panel. The entire system shall consist of two elements: The automatic transfer switch and the bypass-isolation switch furnished completely factory interconnected and tested.
   b. The operating speed of the bypass switch contacts shall be the same as the automatic transfer switch and independent of the speed of operation of the bypass handle.
   c. The automatic transfer and bypass-isolation switch shall be the product of one manufacturer and be completely factory interconnected and tested so that only the service and load connections to the bypass-isolation switch are required for field installation. All interconnections between the transfer switch, bypass switch and isolation switch shall be by silver-plated copper bus bar. A visual position indicator shall be provided to indicate bypass-isolation switch positions, and availability of normal and emergency sources. A prominent and detailed instruction plate shall be furnished for convenient operation.
   d. The automatic transfer and bypass-isolation switch shall provide manual bypass of the load and isolation of all service and load terminals of the automatic transfer switch to permit periodic testing, maintenance, and service of the automatic transfer switch.
   e. The bypass-isolation switch shall be capable of bypassing the load to either source. Provisions shall be made to assure continuity of auxiliary circuits necessary for the proper operation of the system.
   f. The isolation handle shall provide for automatic operation, testing, or removal of the automatic transfer switch. The Test position shall permit electrical testing of the automatic transfer switch without disturbing the load. The open position shall completely isolate the transfer switch from both lines and load without actual removal of the line or load conductors, and allow its removal for inspection, adjustment and maintenance. The transfer switch shall be arranged for drawout operation to facilitate its removal. Also, while in the Test or Open positions, the bypass switch shall function as a manual transfer switch to allow load transfer to either source

of power regardless of the position or condition of the transfer switch, including the condition when the automatic transfer switch is removed, and without reconnecting the load terminals of the automatic transfer switch.

2.04 FUEL SUPPLY

A. A double wall 8000 gallon fuel storage tank for each generator shall be located in the skids below the generator set, and shall be complete with all piping and fittings connected. No galvanized material shall be used in the tank or fueling system. The tanks shall be vented to atmosphere. A fuel level gauge shall be located as indicated on the drawings. The system shall be supplied to deliver an adequate amount of fuel to the engine from the storage tank. Pipe sizes shall be no smaller than the minimum recommended by the engine manufacturer to avoid fuel flow restriction. The engine supply and return line shall be equipped with a length of flexible fuel lines, unions, and gate valves. No copper lines are acceptable. Provide lockable fill, and all venting as required. The tank shall fit within space provided.

B. Provide a work platform around the sides and controls end of the generator, extending a minimum of three (3) feet from the generator, but in no case shall the platform be narrower than the length of the service doors so that the generator remains fully accessible for servicing. The platform shall be provided with a handrail, four feet high. The platform deck shall be equal in elevation to the top of the fuel tank and shall be supported by the concrete pad of the generator. The platform shall be fabricated from welded aluminum tubing, the deck shall be heavy duty aluminum grating, the platform shall be provided with aluminum steps as required to access the working deck elevation. All bolts to be aluminum. All anchor bolts to be stainless steel.

C. Provide a set of normally open contacts in fuel level indicating system of fuel tank. Interconnect with remote low fuel alarm specified earlier in this section.

D. Provide 'Fuel in Containment' contact in basin and Leak Detection System.

E. Provide fuel sensing system for each tank so that if fuel level is over 90% an audible and visual alarm shall alarm. Provide engraved sign reading "DISCONTINUE FILLING IF ALARM SOUNDS."

F. Provide 4000 gallons of fuel for each tank at start of load bank testing.

PART 3- EXECUTION

3.01 EPS INSTALLATION

A. The plant shall be anchored to a concrete base. See structural for slab details. Refer to the detail on the plans

B. Provide a laminated sign at the service entrance equipment indicating type and location of on-site emergency power sources.

C. For exterior installations, the EPS shall be provided in outdoor, weatherproof housing with removable panels for access to equipment. The starting batteries shall be rack mounted within the housing.

D. The enclosure shall be constructed of pre-painted aluminum, panels and posts shall be 0.125" thick (ASTM B209, 5052 H32). The housing shall be wind rated to 150 mph per ASCE 7-98 exposure D, category 1 importance factor. The enclosure shall be required to provide sound attenuation, level 2.

E. Provide LED service lights and weather proof switch within the housing. Connect the light to the battery charger 120 volt circuit. Provide receptacle and battery powered emergency light.

F. Extend 120 and/or 230 volt emergency power circuits for chargers and cold weather starting aids from the control panel wiring system.

3.02 TRANSFER SWITCH INSTALLATION

A. Locate transfer switch(es) to provide working clearance and full accessibility as required by the National Electrical Code.

B. Lace and group conductors installed in transfer switch with nylon tie straps. Only one conductor shall be installed under terminals. Form and train conductors in enclosure neatly parallel and at right angles to sides of box. Uninsulated conductor shall not extend beyond one-eights inch from terminal lug. Conductors shall be installed such that no stresses are transferred to terminal lugs.

C. Mounting and Support

1. Mounting
   a. Enclosure shall be secured to structure by a minimum of four (4) fastening devices to floor.
   b. Do not splice conductors in enclosure. Where required, install junction box or wireway adjacent to transfer switch and splice or tap conductors in box.
   c. Conductors not terminating in transfer switch shall not extend through or enter transfer switch enclosure.
   d. Install push-in knock-out closure plugs in any unused knock-out openings.
   e. Free standing transfer switch(es) shall be installed on a four inch high concrete pad, with horizontal base dimension exceeding base dimension of switch by three inches.
   f. Cleaning and Adjustment
      1) After completion, clean the interior and exterior of dirt, paint and construction debris.

2) Touch up paint all scratched or marred surfaces with factory furnished touch up paint of the same color as the factory applied paint.

3.03 TESTING

A. Submit verification letter to Engineer indicating successful completion of sequence of operations testing and certification that all functions are operational. Letter to request load testing approval and schedule of proposed test. Prior to load test, written approval must be provided by Engineer. Representatives of the generator and transfer switch shall be present. The local authority having jurisdiction shall be given advance notification of the time of the final test in order that he may witness the tests.

B. A failure of any test or any component during a test will require a complete retest program at no additional cost to the Owner.

C. Provide all fuel, lubricants, and other consumables for testing.

D. An on-site acceptance test shall be conducted as a final approval test for all Emergency Power Supply Systems.

1. The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.
2. Test Results. The EPSS shall perform within the limits specified in the standard NFPA-110, Level 1.

3.04 O&M MANUALS

A. At least three sets of an instruction manual(s) for all major components of the EPS shall be supplied by the Manufacturer(s) of the EPS and shall contain:

1. A detailed explanation of the operation of the system.
2. Instruction for routine maintenance.
3. Detailed instructions for repair of the EPS and other major components of the EPS.
4. Pictorial parts list and part numbers.
5. Pictorial and schematic electrical drawings of wiring systems, including operation and safety devices, control panels, instrumentation and annunciators.

3.05 GA POWER DOCUMENTATION AND ACCESSORIES

A. Contractor shall contact GA Power and provide all necessary information as required for new generator with closed-transition transfer switch, ready for owner's signatures.

B. Provide and install a 86 Rolloff N.O. Reset switch for main breaker and all signage as required by Georgia Power.

END OF SECTION

DIVISION 26 – ELECTRICAL

266500 – ELECTRICAL EQUIPMENT ACCEPTANCE TESTING

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. The work required under this section of the specifications consist of the start-up testing and inspection of the electrical equipment designated within. All labor and testing equipment which is required shall be provided under this section of the specifications.

1.03 GENERAL

A. The Contractor shall perform the tests as outlined below to insure system acceptance.

B. When the tests and inspections have been completed, a label shall be attached to all devices tested. The label shall provide the name of the testing company, the date the tests were completed, and the initials of the licensed electrical contractor who performed the tests.

C. The tests shall insure that the equipment is operational and functioning within industry standards and manufacturer's tolerances. Forward all test reports to the Engineer at least two weeks prior to the project final inspection for review. Reports shall be bound as required by Division 1 of this specification.

1.04 QUALITY ASSURANCE

A. The testing and inspection shall comply with all applicable sections of the following codes and standards:

1. American National Standards Institute - ANSI
2. American Society for Testing and Materials - ASTM
3. Association of Edison Illuminating Companies - AEIC
4. Institute of Electrical and Electronics Engineers - IEEE
5. Insulated Power Cable Engineers Association - IPCEA
6. International Electrical Testing Association - NETA Acceptance Testing Specifications
7. National Electrical Code - NEC

8. National Electrical Manufacturers Association - NEMA
9. National Fire Protection Association - NFPA
10. State and Local Codes and Ordinances

B. The inspection and testing shall comply with the project plans and specifications as well as with the manufacturer's drawings, instruction manuals, and other applicable data for the apparatus tested.

1.05 DIVISION OF RESPONSIBILITY

A. The contractor shall perform all tests.

B. The contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.

C. The contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

D. The contractor is responsible for obtaining and approving a short-circuit analysis and coordination study prepared by the switchgear manufacturer.

E. The testing firm shall notify the Engineer prior to commencement of any testing.

F. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Engineer.

G. The electrical contractor shall maintain a written record of all tests and, upon completion of project, shall assemble and certify a final test report.

1.06 SAFETY AND PRECAUTIONS

A. Safety practices shall comply with applicable state and local safety orders as well as with the Occupational Safety and Health Act of 1970 (OSHA). Compliance with the National Fire Protection Association standard NFPA 70E and the Accident Prevention Manual for Industrial Operations of the National Safety Council shall be observed.

B. Tests shall only be performed on apparatus which is de-energized. The testing company's lead test engineer for the project shall be a designated safety representative and shall supervise testing observations and safety requirements. Work shall not proceed until he has determined that it is safe to do so.

C. Power circuits shall have conductors shorted to ground by a hotline grounded device approved for the purpose. Warning signs and protective barriers shall be provided as necessary to conduct the tests safely.

1.07 REPORTS

A. The test report shall include the following sections:

1. Scope of testing
2. Equipment tested
3. Description of test
4. Test results
5. Conclusions and recommendations
6. Appendix, including test forms

B. Each piece of equipment shall be recorded on a data sheet listing the condition of the equipment as found and as left. Included shall be recommendations for any necessary repair and/or replacement parts. The data sheets shall indicate the name of the engineer who tested the equipment and the date of the test completion.

C. Record copies of the completed test report shall be submitted no more than 30 days after completion of the testing and inspection.

1.08 TEST EQUIPMENT

A. All test equipment shall be in good mechanical and electrical condition. All field instruments shall have been calibrated within six months of the testing date, and dated calibration labels shall be visible on the testing equipment. Submit calibration certification in the final report.

PART 2 – PRODUCTS

2.01 MATERIALS

A. All materials are specified under other sections of this specification. All testing equipment required shall be provided under this section of the specifications.

PART 3 - EXECUTION

3.01 EQUIPMENT TO BE TESTED

A. The following equipment shall be tested in accordance with the scopes of work which follow. The party responsible is identified in accordance with the following key: C = Contractor; M = Manufacturer.

1. Dry Type Transformers - C
2. Low Voltage Switchboards - C
3. Molded Case Circuit Breakers - C
4. Motor Controllers – C
5. Automatic Transfer Switches - M
6. Emergency Power Supply-Engine Driven - M

7. Grounding System - C
8. Cables, Low Voltage, 600 Volts Maximum - C
9. Ground Fault Systems - C

3.02 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection

1. With case covers removed, inspect transformer core and coil assembly and enclosure interior. Cloth wipe and/or brush major insulating surfaces.
2. Check primary, secondary, and ground connections.
3. Check tap connections and tap changer.
4. Inspect all bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect insulators, spacers, and windings.
6. Inspect for adequate electrical clearance.
7. Check base or support insulators, including vibration isolation supports.
8. Check accessory devices for condition and proper operation.
9. Verify that the transformers have been provided with adequate spacing for ventilation.

B. Electrical Tests

1. Insulation Resistance Test: Megger transformer windings high to low and ground, low to high and ground, and high and low to ground.
2. Include measured secondary voltage (line-to-line and line-to-ground) for each transformer in the test report. Secondary voltage readings, at each transformer, phase to phase neutral, and phase load readings shall be recorded and tap positions of transformer taps noted. This test shall be conducted with a calibrated voltmeter.
3. Each ground rod installation shall be tested after all connections to ground rods are made before grounding conductor connection is made to the transformer. Ground rod installations shall be tested by "fall of potential" measuring method using ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested.
4. Placement of auxiliary electrodes shall be in accordance with operating instructions of test meter, but in no case shall auxiliary current electrodes be placed within 70' of the grounding system being tested. Test data shall indicate placement of auxiliary electrodes with respect to systems being tested, date readings were taken and lowest resistance recorded.

3.03 LOW VOLTAGE SWITCHBOARDS

A. Visual and Mechanical Inspection

1. Verify that the contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign materials.

2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check for proper travel and alignment of any drawout or plug-in circuit breakers.
4. Check breaker connections to bus.
5. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
6. Inspect for missing or loose hardware or accessories.
7. Inspect ground bus connections.
8. Operate key and door interlock devices to assure proper operation.
9. Test 'arc limiting' switches.

B. Electrical Tests

1. Insulation Resistance Test: Megger main secondary bus and feeder circuits phase-to-phase and phase-to-ground.
2. Energize any space heater circuits to insure proper operations.

C. Check phase rotation with a Biddle phase rotation meter.

D. Instruments and Meter Tests

1. Inspect panel mounted instruments and meters.

3.04 MOLDED CASE CIRCUIT BREAKERS

A. Visual and Mechanical Inspection

1. Inspect cover and case, and check for broken or loose terminals.
2. Operate breaker to check operation.

B. Electrical Tests (400 ampere frame and larger)

1. Insulation Resistance Test: Megger main poles of breaker pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts with breaker closed and latched to check for good, low resistance contact.
3. Test overcurrent trip device and calibrate. Where primary injection testing is specified, test each pole of the breaker individually. Data shall be compared with manufacturer's published data.
   a. All trip units shall be tested by primary injection.
   b. Static overcurrent trip devices shall be tested per manufacturer's instructions.
   c. Test for minimum pick-up current.
   d. Apply 300% of pick-up current and measure time necessary to trip breaker (long time delay).
   e. Where short time delay characteristics are provided, test short time pick-up and delay.
   f. Test instantaneous trip by passing current sufficiently high to trip breaker instantaneously.

g. Where ground fault protection is provided, test ground fault pick-up and delay.
h. Check reset characteristics of trip unit.

4. Electrically test any auxiliary devices such as shunt trips, undervoltage trips, alarm switches, and auxiliary switches.

3.05 MOTOR CONTROLLERS

A. Visual and Mechanical Inspection

1. Verify that the contractor has cleaned structure interiors and starter cells of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
3. Check mechanical operation of starters for freedom from binding.
4. Check motor circuit protector setting and overload relay size against contractor furnished list of motor nameplate full load current values.

B. Electrical Tests

1. Verify operation of each starter.
2. Contact Resistance Test. Ductor across main pole contacts of each breaker or switch with device closed and latched to check for good, low resistance contact.

3.06 AUTOMATIC TRANSFER SWITCHES

A. Visual and Mechanical Inspection

1. Verify that contractor has cleaned enclosure interiors and all components of accumulated of dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defect or failure.
3. Perform inspection checks on individual components as recommended by the manufacturer.
4. Inspect connections for looseness. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Check for proper mechanical operation and lubricate, as necessary.
7. Check transfer mechanism for alignment and friction-free operation. Lubricate, as necessary.
8. Check all connecting wiring for condition.

B. Electrical Tests

1. Use test switch, when available, to check the electrical operation of the transfer switch.
2. When a test switch is not available, a failure of the normal source power will be simulated by disconnecting a voltage sensing lead.

3. Test and adjust all sensing relays, and other devices specifically associated with the transfer switch.
4. Contact Resistance Test: Ductor across main pole contacts of power switching circuit breakers, switches or contactor contacts with device closed and latched to check for good, low resistance contact.
5. Demonstrate bypass operation.

3.07 EMERGENCY POWER SUPPLY-ENGINE DRIVEN

A. Visual and Mechanical Inspection

1. Verify that contractor has cleaned enclosure interiors of accumulated dust, dirt, oil films, and other foreign material.
2. Inspect all electrical and mechanical components for condition and any evidence of defects or failure.
3. Check output circuit breaker(s) bus connection.
4. Inspect bolted connections. The electrical contractor shall torque wrench tighten or remake any questionable connections.
5. Inspect for missing or loose hardware or accessories.
6. Inspect grounding system connections.
7. Operate key and door interlock devices to assure proper operation.
8. Inspect all associated systems and circuits for proper operation, including but not limited to the fuel supply system, jacket heater, battery charger, engine mounted control panel, remote monitoring and control panel, emergency cut-off, battery lighting system, exhaust system, radiator system, and ventilator system.
9. Inspect anchoring and vibration isolation systems.

B. Electrical Tests.

1. Insulation resistance test: Megger main poles of output circuit breaker(s) pole-to-pole, from each pole to ground, and across the open contacts of each pole.
2. Contact Resistance Test: Ductor across main pole contacts of output circuit breaker(s) with breaker closed and latched to check for good, low resistance contact.
3. Follow completely the load testing procedures of the latest issue of NFPA-110 for EPS systems, including prior notification of the local inspection authority having jurisdiction. Include all measured data and conditions in the final report. All non-compliance items shall be corrected by the contractor and retested until full compliance with NFPA-110 is achieved.

3.08 GROUNDING SYSTEM

A. Visual and Mechanical Inspection

1. Inspect wiring system outlet and junction boxes for proper grounding. Green grounding conductor shall be connected to outlet and junction boxes.

2. Verify connections of grounds for the secondary of separately derived grounding systems, i.e. at dry type transformers. Note type of connection, i.e. mechanical or exothermic.
3. Verify proper connection to all components of building service entrance grounding system. Note all system components which are interconnected and type of connection either mechanical or exothermic. Note depth of driven ground rods.

B. Electrical Tests (Small Systems)

1. Perform ground-impedance measurements utilizing the fall-of-potential method per ANSI/IEEE Standard 81 "IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System". Instrumentation utilized shall be specifically designed for ground impedance testing. Provide sufficient spacing so that plotted curves flatten in the 62% area of the distance between the item under test and the current electrode.

C. Equipment Grounds

1. Utilize two-point method of IEEE Std. 81. Measure between equipment ground being tested and known low-impedance grounding electrode or system.

D. Test Values

1. The main ground electrode system impedance-to-ground should be no greater than 25 ohms for commercial or industrial systems. Equipment grounds, depending on size and length of grounding conductor, should be only fractionally higher than system ground.

3.09 CABLES - LOW-VOLTAGE - 600V MAXIMUM

A. Visual and Mechanical Inspection

1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color coding with applicable engineer's specifications and National Electrical Code standards.

B. Electrical Tests

1. Perform insulation-resistance test on each feeder on the riser diagram with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for 1 minute.
2. Perform continuity test to insure proper cable connection.

C. Test Values

1. Evaluate results by comparison with cables of same length and type. Investigate any values less than 50 megohms.

3.10 GROUND-FAULT SYSTEMS (NEC 230-95)

A. Visual and Mechanical Inspection

1. Inspect for physical damage and compliance with drawings and specifications.
2. Inspect neutral main bonding connection to assure:
   a. Zero-sequence sensing system is grounded.
   b. Ground-strap sensing systems are grounded through sensing device.
   c. Ground connection is made ahead of neutral disconnect link on zero-sequence sensing systems.
   d. Grounded conductor (neutral) is solidly grounded.
3. Inspect control power transformer to ensure adequate capacity for system.
4. Manually operate monitor panels (if present) for:
   a. Trip test
   b. No trip test
   c. Nonautomatic reset
5. Record proper operation and test sequence.
6. Set pickup and time-delay settings in accordance with the settings provided by the coordination study.

B. Electrical Tests

1. Measure system neutral insulation to ensure no shunt ground paths exist. Remove neutral-ground disconnect link. Measure neutral insulation resistance and replace link.
2. Determine the relay pickup current by current injection at the sensor and operate the circuit interrupting device.
3. Test the relay timing by injecting three hundred percent (300%) of pickup current, or as specified by manufacturer.
4. Test the system operation at fifty-seven percent (57%) rated control voltage, if applicable.
5. Test zone interlock systems by simultaneous sensor current injection and monitoring zone blocking function.
6. On multiple source, tie breaker, etc., systems, devise a simulation scheme that fully proves correct operation.

C. Test Parameters

1. System neutral insulation shall be a minimum of one hundred (100) ohms, preferably one (1) megohm or greater.
2. Relay timing shall be in accordance with manufacturer's published time-current characteristic curves but in no case longer than one (1) second for fault currents equal to or greater than 3,000 amperes.
3. Relay pickup value shall be within +/- 10% of setting and in no case greater than 1200A.

END OF SECTION

DIVISION 28 – ELECTRICAL

283111.01 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. The work required under this section of the specifications consists of the furnishing, installation and connection of the Fire Alarm System - Low Rise Multiplexed.

B. Definition: The Fire Alarm System consists of an addressable control panel with alarm initiating devices as indicated on the plans for the Belt Press Building and a limited panel for elevator in main building.

1.3 QUALITY ASSURANCE

A. Industry Referenced Standards: The following specifications and standards are incorporated into and become a part of the specification by reference.
   1. Underwriter's Laboratories, Inc. (UL) Publications:
      a. No. 38: Manually actuated signaling box for use with Fire Protective Signaling Systems.
   2. National Electrical Manufacturer's Association (NEMA) Publications:
      a. No. SB3: Interconnection Circuitry of Non-Coded Remote-Station Protective Signaling Systems.
   3. National Fire Protection Association (NFPA):
      a. No. 70: National Electrical Code (NEC)
      b. No. 72A: Local Protective Signaling Systems

B. Acceptable Manufacturers: Products of the following manufacturers which comply with these specifications are acceptable.
   1. Edwards Division; EST
   2. Johnson Controls, Inc.
   3. Notifier
   4. Simplex

C. Coordination:

1. Review shop drawings submitted under this and other sections, as well as other divisions, to insure coordination between work required among different trades. Coordinate the installation sequence with other contractors to avoid conflicts and to provide the fastest overall installation schedule. Coordinate installation with architectural and structural features, equipment installed under other sections of the specifications, and electrical equipment to insure access and so that clearance minimums are provided.

D. Installer's Qualifications: Firm with at least 5 years of successful installation experience on projects with fire alarm systems work similar to that required for this project.
   1. Firm with manufacturer's factory trained personnel.
   2. Firm with factory authorized service organization and spare parts stock.

1.4 SUBMITTALS

A. Refer to BASIC ELECTRICAL REQUIREMENTS section for submittal requirements.

B. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each type of fire alarm system equipment. Include standard or typical riser and wiring diagrams, and operation and maintenance instructions for inclusion in maintenance manuals.

C. Wiring Diagrams: Submit dimensioned floor plan drawings (minimum 1/16 inch scale) for each floor plan indicating all device locations with corresponding zone next to device. Zoning shall include initiation and audio zone where applicable. Plans shall include all conduit and wiring requirements indicating system interconnection, number and size of conductors and appropriate conduit size, and ancillary devices such as end-of-line resistors. Include wiring and riser diagrams.

D. Isometric Detail: Provide isometric detail for Fire Alarm Control Panel indicating all component features and space requirements.

E. Maintenance Data: Submit maintenance data and parts lists for each type of fire alarm equipment installed, including furnished specialties and accessories. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

F. Manufacturer Certification: Submit a letter from the manufacturer's representative stating the proposed system being submitted for review complies with the specification and takes no exception.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Handle fire alarm equipment carefully to prevent damage, breaking, and scoring. Do not install damaged equipment or components; replace with new.

B. Store fire alarm equipment in clean, dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 - PRODUCTS

2.1 FIRE ALARM AND DETECTION SYSTEMS:

A. General: Provide complete fire alarm system products of types, sizes, and capacities indicated, which comply with manufacturer's standard design, materials, components; construct in accordance with published product information, and as required for complete installation. Provide fire alarm and detection systems for applications indicated.
   1. Combination, Non-Coded: Either manual activation of fire alarm station or activation of automatic initiating device will energize fire alarm system signaling devices and sound non-coded alarm.

B. Design system for alarm sounding continuously throughout facility.

C. System Wiring and Supervision:
   1. Provide Class 1 initiating and alarm circuits with electrical supervision for shorts and open conditions.
   2. Install diodes or resistors in fire alarm control cabinet.
   3. Power Supplies: Provide system for operation on 120 VAC power supply. Arrange control system for operation of primary power supply and trouble power supply to operate from opposite legs of three wire system.
   4. Provide battery back-up as secondary power supply. Design battery back-up to take over supply to system within 30 seconds of loss of primary system to 85% voltage. Provide battery system capable of operation of system for 24-hours under normal conditions and then for five minutes under alarm conditions.

D. Optional System Features: Provide the following features in addition to the basic system features specified elsewhere in this specification
   1. Auxiliary contacts, normally open. Provide one contact for annunciation to SCADA system for alarm and trouble for all systems.

E. System Materials: Provide basic wiring materials which comply with Division 16 Basic Electrical Materials and Methods sections, RACEWAYS and BOXES, types to be selected by Installer.

1. Provide conductors which are listed and approved for fire alarm usage. All wiring shall be installed in conduit. Minimum size conduit shall be ¾".

2.2 SYSTEM OPERATION

A. Actuation of any alarm initiation device shall automatically initiate the following:
   1. Illuminate the system priority one alarm LED, cause an audible alarm signal to sound, display the alarm condition language message for the point in alarm at the Central Control Station.
   2. Cause all alarms to sound, all visual alarms (including exit light) to flash.
   3. Provide a signal for connection to the SCADA panel.

B. The fire alerting tone shall be a low to high "slow whoop" from 200 Hz to 830 Hz nominal lasting 2.5 seconds.

C. It shall be possible to silence the alarm signals by operating the acknowledge switch causing the zone alarm LED to cease flashing and remain illuminated. However, the activation of another zone shall repeat the entire alarm process thus causing the signals to resound.

2.3 SYSTEM FEATURES

A. The system shall include the following features as a minimum:
   1. All alarm initiating circuit wiring, signal circuit wiring, and alarm circuit wiring supervised.
   2. Automatic transfer to standby batteries upon power failure.
   3. Solid state, microprocessor based circuitry.
   4. Full supervision of all communication, monitor and signal wiring.
   5. User programmable with keyboard.
   6. Modular design to allow future expansion with a minimum of hardware additions.
   7. System automatically switches to battery operation upon loss of 60 Hz power.
   8. Operation shall not require personnel with special computer operation skills.
   9. All messages generated by the software shall be "user friendly" in plain English, not computer language. Messages shall describe condition and, based on input from the Owner, provide plain language instructions for building personnel.

2.4 FIRE ALARM PANEL

A. Provide surface mounted fire alarm panels where shown. Panels shall include all controls and batteries to supervise and annunciate all devices.

B. In Belt Press Building, install panel inside a NEMA 4X box with clear cover.

C. For main building, provide limited panel feature for elevator area only.

2.5 MANUAL FIRE ALARM STATIONS

A. Provide manufacturer's standard construction, red enclosure, manual fire alarm stations with the following features:
   1. High Impact Lexan
   2. Surface mounted
   3. Non-coded
   4. Non-breakglass operation
   5. General alarm
   6. Single action
   7. Institutional cover

B. For Belt Press Building, all devices shall be rated NEMA 4X.

2.6 HORNS/AUDIBLE

A. Provide manufacturer's standard construction fire alarm horn with following features:
   1. Non-coded
   2. Surface mounted (with grille)
   3. Single projection
   4. Alarm light with white lens lettered red "FIRE"

B. For Belt Press Building, all devices shall be rated NEMA 4X.

2.7 ALARM LIGHTS

A. Provide manufacturer's standard construction alarm lights with the following features:
   1. White lens, plain or lettered red "FIRE".
   2. 24-volt DC Xenon flasher.

2.8 SMOKE OR THERMAL DETECTORS

A. Provide photoelectric smoke detectors or rate of rise thermal detector where shown. All to be addressable.

2.9 TEST CHART INSTRUCTIONS

A. Provide fire alarm system test instructions chart mounted in lexan enclosed frame assembly on control cabinet hinged door.

PART 3 - EXECUTION

3.1 EXAMINATION:

A. Examine areas and conditions under which fire alarm systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BASIC IDENTIFICATION:

A. Install electrical identification in accordance with Division-26 Basic Electrical Materials and Methods section "Electrical Identification."

3.3 INSTALLATION OF BASIC WIRING SYSTEM MATERIALS:

A. Install wiring, raceways, and electrical boxes and fittings in accordance with Division-26 Basic Electrical Materials and Methods sections, "Raceways", "Wires and Cables", and "Boxes" for wiring of non-power limited circuits. Conduit, boxes, etc shall be painted red.

B. Install wires and cables without splices. Make connections at terminal strips in cabinets or at equipment terminals. Make soldered splices in electronic circuits in control cabinets.

3.4 INSTALLATION OF FIRE ALARM SYSTEMS:

A. Install fire alarm system as indicated, in accordance with equipment manufacturer's written instructions and complying with applicable portions of NEC and NECA's "Standard of Installation."

B. Wiring: Wiring of fire alarm system is work of this section, but is not specifically detailed on drawings.

1. Complete wiring in accordance with manufacturer's requirements. Color code wiring and install per manufacturer's point-to-point wiring diagram. Determine exact number of wires for each fire area zone from number and types of devices installed. Connect each device with sufficient wiring to complete its intended operation.
2. Where there are a number of power requiring devices such as smoke detectors, fan relays, door holders and smoke damper operators installed in a circuit, group in numbers so power required does not exceed 80% of manufacturer's power supply rating. Provide extra wiring, or extra power supplies required to fulfill that requirement. In addition, provide extra or larger size wiring to alleviate voltage drops which makes device operate beyond voltage limits for which it was

designed. Determine above with manufacturer's representative while equipment is being installed.

3.5 FIELD QUALITY CONTROL:

A. Connection and Supervision: Make connections to panel under manufacturer's supervision. Run wiring to main terminal cabinet located adjacent to main fire alarm panel. Complete connections from this cabinet to panel utilizing Manufacturer's technicians.

B. System Test and Approval: Submit shop drawings for function and operation only, pre-approved by authority having local jurisdiction.
   1. Prior to final acceptance of system, manufacturer of system shall, in presence of Contractor, Owner's Representative and Architect's representative, test each sensing or detection and alarm device.
   2. Submit copy of test results in duplicate after signed by Owner's Representative to Architect, Owner, Owner's Insurance Company and local Fire Protection Authority. Mount copy of inspection record in lexan enclosed frame assembly on control panel.

C. Upon project completion, the manufacturer's representative shall present for the Owner's consideration a proposal to provide semi-annual inspection and tests of the system.

END OF SECTION

Geotechnical Engineering Investigation

Travis Field WWTF
Savannah, Georgia

March 15, 2018
Terracon Project No. ES185011

Prepared for:

Thomas & Hutton
Savannah, Georgia

Prepared by:

Terracon Consultants, Inc.
Savannah, Georgia

March 15, 2018

Thomas & Hutton
50 Park of Cemmerce Way
Savannah, Georgia 31405

Attn: Mr. Fred Sororian, P.E.
Project Manager
P: (912) 721 4128
E: sororian.f@thomasandhutton.com

Re: Geotechnical Engineering Investigation
Travis Field WWTF
Savannah, Georgia
Terracon Project No. ES185011

Dear Mr. Sororian:

Terracon Consultants, Inc. (Terracon) has completed our Geotechnical Engineering Investigation for the above-referenced project. The services were performed in general accordance with the signed subcontract for services dated January 24, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations for the proposed construction.

We appreciate the opportunity to be of service to you. Should you have any questions concerning this report or if we may be of further service, please contact us at your convenience.

Sincerely,
Terracon Consultants, Inc.

GEORGIA Registered PROFESSIONAL Engineer GUOMING LIN

Yan Jiang, Ph.D., P.E.
Senior Staff Engineer

Guoming Lin, Ph.D., P.E., D.GE.
Senior Principal

cc: 1 – Client (PDF)
1 – File

TABLE OF CONTENTS

APPENDICES

EXECUTIVE SUMMARY

This report presents the results of our Geotechnical Engineering Investigation for the proposed improvements at the Travis Field Waste Water Treatment Facility (WWTF) with associated driveways and parking area within the Georgia Air National Guard at the southeast corner of the Savannah/Hilton Head International Airport in Savannah, Georgia. The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations.

Based on the results of the subsurface exploration and analyses, we identified the following geotechnical considerations:

- In general, the subsurface soils consist of sandy clays in the upper 11 feet below ground surface (BGS), followed by a layer of variable soils including clayey sands or sands with clays and sandy clays to elevations of -12 to -14 feet. Below this layer of variable soils are sands with clays or silts or silty sands to elevations of -26 to -38 feet followed by sandy silts (Marl) to the termination of SPT boring at an elevation of about -51 feet. A detailed discussion about the subsurface conditions is provided in **Section 3.1**.
- Groundwater depth was measured at approximately depths of 3 to 12.5 feet BGS (corresponding to elevations of 8 to 6.5) within the SPT borings at the time of our field exploration and 24 hours after the field exploration. The groundwater level should be checked prior to construction in order to assess its effects on site work and other construction activities.
- We performed settlement analyses using the provided structural loads as discussed in Section 2.0, and soil profiles and parameters obtained from the field exploration. Based on the settlement analyses, we conclude that the effluent pump station can be supported on a shallow foundation. The proposed new treatment tank and building for new sludge dewatering system should be supported on a deep foundation system.
- Three commonly used pile foundations: prestressed concrete (PSC) piles, steel H-piles and augered cast-in-place (ACIP) piles were evaluated for the deep foundation system. See calculated pile capacities in Section 4.6 of this report.
- A net allowable bearing capacity of 2,500 pounds per square foot (psf) is recommended for the shallow foundation design. The allowable bearing capacity may be increased by 1/3 for transient wind load and seismic load conditions.
- For the seismic design, Terracon classifies the subject site as Site Class D in accordance with the International Building Code IBC (2012) and ASCE 7-10 Section 11.4.2.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and **the report must be read in its entirety** for a comprehensive understanding of the items and recommendations contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report's limitations.

GEOTECHNICAL ENGINEERING INVESTIGATION

Travis Field WWTF
Savannah, Georgia

Terracon Project No. ES185011
March 15, 2018

1.0 INTRODUCTION

Terracon has completed our Geotechnical Engineering Investigation for the proposed new construction at the existing Travis Field Waste Water Treatment Facility (WWTF) with associated driveways and parking area within the Georgia Air National Guard at the southeast corner of the Savannah/Hilton Head International Airport in Savannah, Georgia. The general location of the project site and its vicinity are shown on the Site Location Map in **Exhibit A-1**, **Appendix A**.

The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations. The subsurface conditions within the proposed site were explored with seven Standard Penetration Testing (SPT) borings. The SPT borings were drilled to depths of approximately 35 to 70 feet below ground surface (BGS). The boring locations are shown in **Exhibit A-2, Appendix A**. Detailed boring logs are also included in **Appendix A**.

The purpose of our investigation was to evaluate the existing subsurface conditions at the project site and develop conclusions and geotechnical recommendations for the proposed construction. The following study was conducted in accordance with our scope of services outlined in the signed subcontract for services dated January 24, 2018:

- subsurface soil conditions
- site preparation
- seismic considerations
- groundwater conditions
- foundation design and construction
- pavement recommendation

2.0 PROJECT INFORMATION

Item	Description
Site location	The site is located within the Georgia Air National Guard at the southeast corner of the Savannah/Hilton Head International Airport in Savannah, Georgia. Latitude: 32.1131°, Longitude: -81.1863°

Item	Description
Existing improvements	Travis Field Water Reclamation Facility.
Current ground cover	The site has a waste water pond, two tanks, pipelines, other facility buildings.
Existing topography	The dike top around the waste water pond is at an elevation of 19 feet which is about 6 to 7 feet higher than other area of the project site.
Proposed improvements	The proposed project will include the construction of new waste water treatment facility with associate driveways and parking area.
Finished floor elevation	The bottom of the tank is at an elevation of 12 feet based on the document of "Hydraulic Profile" provided by Thomas & Hutton.
Maximum loads	Based on an email communication with Mr. Fred Sororian of Thomas & Hutton on February 27, 2018, we understand that a concrete treatment tank will be constructed in Phase I to hold about 1.5 million gallon water. The tank is 200 feet long, 80 feet wide, and 22 feet high. The tank wall is about 24 inches thick and the tank bottom is about 32 to 36 inches thick. The total weight of the tank with 1.5 million gallon water is about 23,400 kips and the corresponding slab load is about 1,460 psf. Based on the oral communication with Mr. Fred Sororian of Thomas & Hutton on March 6, 2018, we understand that the bottom of the slab of the pump station will be constructed at an elevation of about -7 feet. The wall of the pump station will be 20 feet high and the slab of the pump station will be 25 feet long and 25 feet wide. The thickness of the wall and the slab is about 12 and 20 inches, respectively. Assuming the pump station can hold the 9,062 ft^3 water (based on the water level in the pump station is at an elevation of 8.5 feet as shown in Hydraulic Profile provided) and the total weight of the pump station with the water is about 1,022 kips. Since the effluent pump station is constructed underground, the estimated buoyancy force due to groundwater will be about 780 kips. Based on an email communication with Mr. Fred Sororian of Thomas & Hutton on March 6, 2018, we understand that the new sludge dewatering system will be construction on the final grade with a prefabrication metal building. This building has an 18 inch thick slab with 1500 psf slab load. **We assume that no additional fill will be added on site for the settlement analyses.** If heavier structural loads are required or if more stringent settlement criteria are required, Terracon should be retained to perform an additional evaluation.
Maximum allowable settlement	The following settlement criteria were assumed for the settlement analyses. Total settlement: 1 inch (assumed). Differential settlement: ½ inch over 40 feet (assumed).

Item	Description
Grading	The existing Water Reclamation Facility including the pond, two tanks, roads, other buildings will be demolished. It is anticipated the site will be graded with a minimal amount of cut and fill.

Should any of the above information or assumptions be inconsistent with the planned construction, Terracon should be informed so that modifications to this report can be made as necessary.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of our field exploration program, we developed generalized soil profiles to represent the soil conditions of the project site, and they can be generalized as follows:

Description	Approximate Elevation to Bottom of Stratum (BGS)	Soil Classification based on SPT borings	Blow Counts
Stratum 1	8 feet	Sandy clays	13 to37
Stratum 2 (variable soils)	-12 to -14 feet	Clayey sands or sands with clay	0 to 14
		Sandy clays	
Stratum 3	-26 to -38	Sands with clays or silt or silty sands	14 to 50+
Stratum 4	-51 feet (SPT termination)	Sandy silts (Marl)	40 to 50+

Note: The existing grades range from EL. 19.0 to 11.8, but mostly at EL 19.0.

Details of subsurface conditions encountered at each boring location are presented in the individual SPT boring logs in **Appendix A** of this report. Stratification boundaries on the logs represent the approximate depth of changes in soil types; the transition between materials may be gradual.

3.2 Groundwater

Groundwater depth was measured at approximately depths of 3 to 12.5 feet BGS (corresponding to elevations of 8 to 6.5 feet) within the SPT borings at the time of our field exploration and 24 hours after the field exploration. Please refer to the individual boring for groundwater depth encountered in each test location. It should be noted that groundwater levels tend to fluctuate with tidal, seasonal and climatic variations, as well as with construction activities. As such, the possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. The groundwater table should be checked prior to construction to assess its effect on site work and other construction activities.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

The following evaluation and recommendations are based upon our understanding of the proposed construction and the results from our field exploration. If the above-described project conditions are incorrect or changed after this report, or subsurface conditions encountered during construction are significantly different from those reported, Terracon should be notified and these recommendations must be re-evaluated to make appropriate revisions.

4.1 Geotechnical Considerations

The generalized soil profile is presented in **Section 3.1**. We performed settlement analyses using the structural loads and soil profiles and parameters derived from the SPT borings. The structural loads were discussed in Section 2.0. Based on the results of our settlement analyses, the total settlement of the effluent pump station was estimated to be less than 1.0 inch. As such the effluent pump station can be supported by a shallow foundation system. If heavier structural loads are required or if more stringent settlement criteria are required, Terracon should be retained to perform an additional evaluation.

For the new treatment tank and building for the sludge dewatering system, the total settlements were estimated to be greater than 1.0 inch. As such, a deep foundation system is required to mitigate the risk of settlement.

Three commonly used piles, augered cast-in-place (ACIP) piles, prestressed concrete (PSC) piles, and steel H-Piles were evaluated to support the new treatment tank and building for the sludge dewatering system. We performed pile capacity analyses for these three types of piles. In general, the piles shall be installed at least 5 feet into the Marl formation which appeared at an elevation of -33 feet. The estimated pile capacities and pile installation recommendations are presented in Section 4.6 of this report.

In addition, since the effluent pump station will be constructed underground, the buoyancy force due to the ground water will be about 780 kips. As such, the lowest water level in the pump station should be sustained in order to overcome an uplift due to this buoyancy force.

We understand that the existing pond, two tanks, roads, and other buildings will be demolished and sludge, waste or unsuitable materials encountered during the demolition need to be excavated and removed. Any undercuts should be backfilled with well compacted fills which should be a non-plastic granular material containing less than 25 percent fines passing the No. 200 sieve.

Based on the hydraulic profile dated Mach 7, 2018 provided by Thomas & Hutton, several pipelines will be buried in the ground to connect the new tank and pump stations and other equipment. The differential settlement will increase the risk of the damage of the pipeline system. We recommend the connection between pipelines and equipment be able to accommodate the differential settlements in order to reduce the risk of the damage of the pipeline system.

4.2 Subgrade Preparation

The site clearing should strip topsoil, rootmat and organics after the demolition of the existing pond, two tanks, roads, and other buildings. Roots larger than one inch in diameter should be cut off two feet beneath the top of the subgrade. During the subgrade preparation, sludge, waste and unsuitable materials within ponds and two tanks, and the near-surface soils with organics / soft soils (muck) should be removed. Furthermore, to minimize the disturbance of the natural soils during the site work, we recommend track mounted lightweight equipment should be used as opposed to a rubber tired machine.

The SPT boring of B7 shows that the location of the effluent pump station has soft / weak soils underneath the slab of the effluent pump station which requires deeper undercut and backfill to achieve a stable subgrade. As such, the contractor should be prepared to stabilize the ground by undercutting and backfilling of these soft areas. The actual depth of undercut should be determined in the field by Terracon based on the subgrade conditions encountered in the field.

The subgrade soils may lose some of their strengths when rain and surface water infiltrates into them. We recommend an effective drainage system be installed in the proposed construction area to intercept rain and surface water.

We recommend a thorough field quality control program of proofrolling of the subgrade. The bottom of the excavation should be observed for potential unsuitable material. Hand auger boring and dynamic cone penetration (DCP) testing should be performed to evaluate and confirm the subgrade conditions. It is anticipated that some deeper subgrade soil undercutting and backfilling may be required in some isolated areas under the buildings and the parking lots during the subgrade preparation.

During the site preparation, no topsoil, organic matter, stumps, undocumented fill or other unsuitable materials should be left in place below any footings, slab and/or pavement. All foundation should bear on suitable natural soil, or on properly compacted structural fill. Compacted fill below any foundation should be placed directly on suitable natural soils.

We recommend Terracon be retained to test the footing, slab and/or pavement subgrade during construction so that Terracon can provide additional recommendations to prepare the subgrade based on the conditions uncovered during the subgrade preparation.

The following sections will present the details of earthwork and the recommendations for shallow foundations.

4.3 Earthwork

Site preparation should include the installation of a site drainage system, the demolition of the existing pond, two tanks, roads and other buildings, topsoil stripping and grubbing, subgrade preparation, densification, and proofrolling. Due to the uneven ground surface of the site, the volume of topsoils may be significantly greater than the area times the topsoil thickness indicated in the boring logs. Deeper undercut may be needed in some localized areas to remove unsuitable materials.

4.3.1 Site Drainage

An effective drainage system be installed prior to site preparation and grading activities to intercept surface water and to improve overall shallow drainage. The drainage system may consist of perimeter ditches supplemented with parallel ditches and swales. Pumping equipment should be prepared if the above ditch system cannot effectively drain water away from the site, especially during the rainy season. The site should be graded to shed water and avoid ponding over the subgrade.

4.3.2 Densification and Proofrolling

Prior to fill placement on the subgrade, the entire plant areas should be densified with a heavy-duty vibratory roller to achieve a uniform subgrade. The subgrade should be thoroughly proofrolled after the completion of densification. Proofrolling will help detect any isolated soft or loose areas that "pump", deflect or rut excessively, and also densify the near-surface soils for floor slab support.

A loaded tandem axle dump truck, capable of transferring a load in excess of 20 tons, should be utilized for this operation. Proofrolling should be performed under the Geotechnical Engineer's observation. Areas where pumping, excessive deflection or rutting is observed after successive passes of the proofrolling equipment should be undercut, backfilled and then properly compacted. It is anticipated that some amount of subgrade undercutting may be required under the footing during subgrade preparation.

4.3.3 Fill Material Consideration

Structural fill should be placed over a stable or stabilized subgrade. The properties of the fill will affect the performance of the footings and the floor slabs. The soils to be used as structural fill should be free of organics, roots, or other deleterious materials. It should be a non-plastic granular material containing less than 25 percent fines passing the No. 200 sieve.

Based on SPT borings, the project site mainly consists of sandy clays at an elevation of 12 feet where the bottom of new treatment tank is. The sandy clays are not suitable for structural fill. As such, it is anticipated that an offsite borrow source is required for the structural fill material.

Areas to receive structural fills should be placed in thin (8 to 10 inches loose) lifts and compacted to a minimum of 95 percent of the soil's Modified Proctor maximum dry density (ASTM D-1557). The fill brought to the site should be within 3 percent (wet or dry) of the optimum moisture content and should meet the properties as described above.

Some manipulation of the moisture content (such as wetting, drying) will be required during the filling operation to obtain the required degree of compaction. The manipulation of the moisture content is highly dependent on weather conditions and site drainage conditions. Therefore, the contractor should prepare both dry and wet fill materials to obtain the specified compaction during grading.

4.4 Slab Foundation

The effluent pump station can be supported by a shallow foundation system, provided that the proposed structure will not exceed the structural loads as provided in Section 2.0 and the structure has a criterion of the allowable settlement of 1 inch or greater. The following sections present design recommendations and construction considerations for the shallow foundations for the proposed structures and related structural elements

4.4.1 Slab Design Recommendations

Item	Description
Floor slab support	Compacted structural fill / inspected and tested natural ground[1].
Modulus of subgrade reaction	120 pounds per square inch per in (psi / in) for point loading conditions.
Net allowable bearing pressure[2]	2,500 psf
Approximate total settlement [3]	<1 inch
Base course/capillary break[4]	4 inches of free draining granular material.
Vapor barrier	Project Specific[4].
Ultimate Coefficient of sliding friction [5]	0.32

1. The slab design should include a base course comprised of free-draining, compacted, granular material, at least 4 inches thick. The granular subbase may be graded aggregate base (GAB) or sands containing less than 5 percent fines (material passing the #200 sieve). GAB subbase can also help improve the workability of the subgrade, especially during rain periods.
2. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the base elevation. It assumes any unsuitable fill or soft soils, if encountered, will be replaced with compacted structural fill.
3. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the foundation, the thickness of compacted fill, and the quality of the earthwork operations.
4. The use of a vapor retarder should be considered beneath concrete slabs on the grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer should refer to ACI 302 and/or ACI 360 for procedures and cautions regarding the use and placement of a vapor retarder. Water proofing should be performed for below ground structures.
5. Sliding friction along the base of the slab will not develop where net uplift conditions exist.

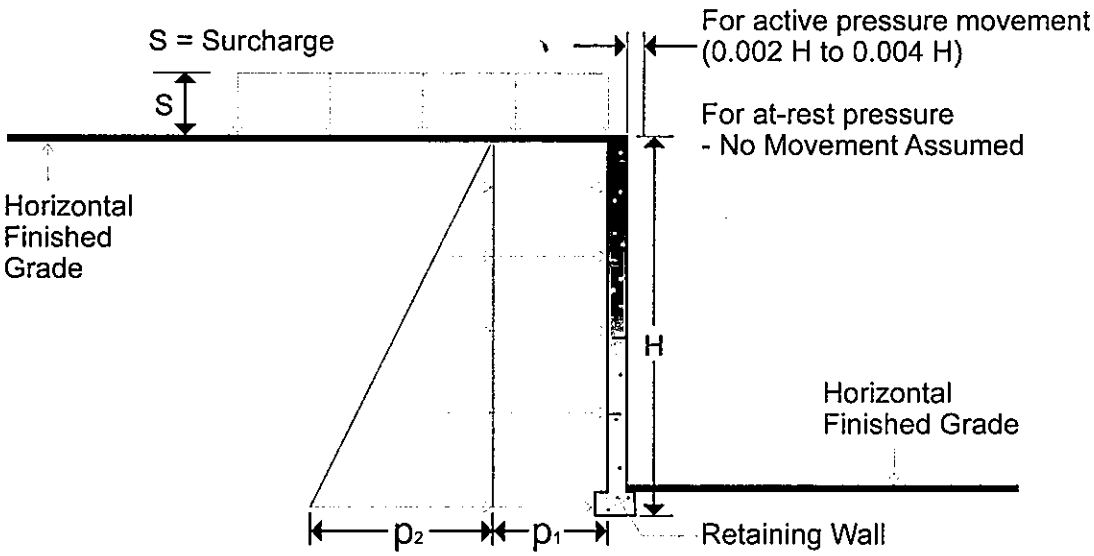
4.4.2 Floor Slab Construction Considerations

Prior to construction of grade supported slabs, varying levels of remediation may be required to reestablish stable subgrades within slab areas due to construction traffic, rainfall, disturbance, desiccation, etc. As a minimum, the following measures are recommended:

- The interior trench backfills placed beneath slabs should be compacted in accordance with recommendations outlined in **Section 4.3** of this report.
- All floor slab subgrade areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to placement of the stone base and concrete.

4.5 Lateral Earth Pressure Considerations

This project does not include independent retaining walls. However, the effluent pump station constructed underground with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. The earth pressure parameters are recommended based on the structural fills specified in the Structural Fill section of our report. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement. The recommended design lateral earth pressures do not include a factor of safety or possible hydrostatic pressure on the walls.



Earth Pressure Coefficients

Earth Pressure Conditions	Coefficient for Backfill Type	Equivalent Fluid Density (pcf)	Surcharge Pressure, p_1 (psf)	Earth Pressure, p_2 (psf)
Active (K_a)	Granular - 0.31	38	(0.31)S	(38)H
At-Rest (K_o)	Granular - 0.47	57	(0.47)S	(57)H
Passive (K_p)	Granular - 3.3	400	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 **H** to 0.004 **H**, where **H** is wall height
- For passive earth pressure to develop, wall must move horizontally against the fill to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- In situ soil backfill weight a maximum of 120 pcf
- Horizontal backfill, compacted between 95 percent of modified Proctor maximum dry density
- Loading from heavy compaction equipment or dynamic loading not included
- No hydrostatic pressures acting on wall
- No safety factor included in soil parameters

Backfill placed against structures should consist of granular soils. The granular backfill must extend out from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively. To calculate the resistance to sliding, a value of 0.35 should be used as the ultimate coefficient of friction between the footing and the underlying soil.

Depending on the depth of excavation and long term groundwater conditions, the unbalanced hydrostatic pressure may be considered in the design of the retaining wall. To control hydrostatic pressure behind the wall, we recommend that a drain be installed at the foundation wall with a collection pipe leading to a reliable discharge such as a stormwater drain. If this is not possible, hydrostatic pressure should be added to the lateral earth pressures recommended above. These pressures do not include the influence of surcharge, equipment or floor loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided.

4.6 Pile Foundation Recommendation

We evaluated three types of piles to support the new treatment tank and building for the sludge dewatering system. We analyzed pile axial and lateral capacities for 12 and 14-inch Prestressed Concrete (PSC) piles, 12 and 14-inch steel H-piles, and 14 and 16-inch diameter auger cast piles. This section describes the procedures for pile capacity evaluations and presents our recommendations for the pile axial and lateral capacities.

4.6.1 Axial Pile Capacity

4.6.1.1 Driven Piles

The pile allowable axial compression and tension capacities were analyzed using the α and β methods and based on our experience with pile capacities in this area. A factor of safety of 2.0 was used for side resistance and a factor of safety of 3.0 was used for tip resistance in the allowable pile capacities. The allowable axial capacities for the 12 and 14-inch PSC piles and 12 and 14-inch steel H-piles are listed in the table below. To improve the driving conditions, we recommend the PSC piles be manufactured using concrete with a 28-day compression strength of 7,000 psi and an effective prestressing of 1,000 psi

We understand the site will be prepared and graded prior to the construction of the foundation. Hence, the downdrag forces were not considered in the pile compressive capacities analysis, otherwise a downdrag force of 30 to 50 tons should be considered.

Recommended Allowable Axial Load Capacities for PSC Piles and steel H-Piles

Embedment Depth* (feet)	Pile Tip Elevation (feet)	12-inch PSC	14-inch PSC	HP12X53	HP14x73
Allowable Compression Capacities (tons)					
45	-33	55	65	40	50
50	-38	65	75	45	54
55	-43	75	85	50	60
Allowable Tension Capacities (tons)					

45	-33	35	40	20	25
50	-38	40	45	25	30
55	-43	45	50	30	35

Note: assuming pile top at an elevation of 12 feet.

We recommend that center-center spacing between adjacent piles be maintained at least three times the pile side dimension. Piles installed less than the recommended spacing may result in driving difficulty or pile heave. Close attention should be directed during construction to observe potential pile heave. If pile heave is observed, the driving procedures or sequence may be adjusted to reduce or eliminate pile heave and heaved piles should be re-taped before cutoff.

4.6.1.2 Augered Cast-In-Place Pile

Continuous flight auger (CFA) piles or conventionally called auger cast piles (or augered cast-in-place) can also be used for the support of the new treatment tank and building for the sludge dewatering system. Augered cast-in-place (ACIP) piles can be installed more quickly than driven piles and generate less noise and vibration. We analyzed pile axial and lateral capacities for 16-inch and 18-inch diameter ACIP Piles. We recommend the ACIP pile should have concrete with a minimum compression strength of 5,000 psi at 28-days.

Analyzed pile axial capacities for the ACIP piles are listed in the table below. Based on the pile configuration and soil parameters from the subsurface exploration, we calculated the allowable axial compression and the tension capacities using the α and β methods and based on our experience with pile capacities in this area. A factor of safety of 2.0 was used for side resistance and a factor of safety of 3.0 was used for tip resistance in the allowable pile capacities.

Embedment Depth (feet)	Pile Tip Elevation (feet)	14-inch ACIP	16-inch ACIP
Allowable Compression Capacities (tons)			
45	-33	40	45
50	-38	50	55
55	-43	60	65
Allowable Tension Capacities (tons)			
45	-33	20	25
50	-38	30	30
55	-43	35	40

Note: assuming pile top at an elevation of 12 feet.

4.6.2 Lateral Pile Capacity

Behavior of the piles under lateral loads was analyzed using the computer program LPILE. The LPILE program employs the *p-y* method based on the user-specified soil and pile properties. The deflections, rotations, and bending moments in the pile were calculated by solving the beam bending equation using finite difference numerical techniques. The allowable lateral pile capacities will be a function of the allowable lateral deflection at the pile top. The pile head deflections will be largely determined by the type of connections between pile head and pile cap. The actual connection may fall somewhere between fixed head and free head conditions. The upper portion of the piles should have adequate reinforcement designed for the required lateral loads.

4.6.2.1 Driven Pile

The recommended lateral design capacities of driven piles are listed in the table below and the results of our analyses are presented in **Appendix B**.

Recommended Pile Lateral Design Capacities (kips)

	12inch PSC	14inch PSC	HP12x53	HP14x73
Free Head Connection	10	14	9	13
Fixed Head Connection	24	31	21	29

Note: Based on an allowable lateral deflection of 0.25 inches.

4.6.2.2 Augered Cast-In-Place Pile

The recommended lateral design capacities of ACIP piles are listed in the table below and the results of our analyses are presented in **Appendix B**.

Recommended Pile Lateral Design Capacities (kips)

	14 inch ACIP	16 inch ACIP
Free Head Connection	11	14
Fixed Head Connection	26	33

Note: Based on an allowable lateral deflection of 0.25 inches.

4.6.3 Pile Testing and Monitoring

4.6.3.1 Driven Pile

Due to the critical nature of the project, a pile monitoring and testing program is very important during production pile installation. The testing program will be required for the confirmation of pile lengths and capacities and the determination of pile driving criteria. Terracon should be retained for the monitoring and testing of the pile installation. Pile testing using pile driving analyzer (PDA) testing is recommended to measure driving stresses, evaluate hammer performance and verify pile capacities. PDA testing should be performed on at least one pile. The test pile can be a production pile.

Proper selection of a driving system is very important to install the recommended piles to the required depth and capacities. The hammer should have adequate energy to allow the piles to penetrate into the Marl formation without introducing damaging driving stresses. The hammer should not generate excessive driving stresses to result in pile damage. Terracon requests an opportunity to evaluate the driving equipment and procedures after the pile hammer, pile cushion and driving procedures have been selected. We will perform a wave equation analysis of the proposed driving system. The driving system and procedures can be accepted only after a pile testing program.

During production pile installation, a Terracon geotechnical engineer should observe the initial pile installation. The purpose of the observation is to determine if the recommendations have been implemented. The geotechnical engineer or an engineering technician working under the direction of the geotechnical engineer should monitor the entire driving process. Complete driving and installation records should be maintained. For each pile driven, driving records should at least include pile type and dimensions, pile tip and cut-off elevations, butt deviation, time to set up, time of driving, plumbness, penetration resistance values for each foot and any incidents relevant to the pile foundation installation such as pile damage or break-down of driving equipment. The geotechnical engineer should review the driving records and recommend necessary adjustments to achieve the design objectives.

4.6.3.2 Augered Cast-In-Place Pile

The purpose of the ACIP pile test program is to verify the contractor's installation procedures and the estimated pile capacities. Installation procedures, refusal criteria if encountered, and pile capacities may be adjusted based on the results of the pile test program. We recommend that at least one (1) test (probe) piles were selected for load testing. The probe piles should be grouted as production piles but located outside the foundations. Additional test piles should be installed if more than one pile size is considered or significantly different conditions are encountered among the test piles. The geotechnical engineer should help select locations for the test piles based on the soil conditions. The test program should be performed under the supervision of the geotechnical engineer.

We recommend static load testing be performed on at least one (1) pile. Additional test piles with varying length may be performed to provide information for a potentially more economical foundation design. The test piles should be loaded to at least three (3) times of the design load. The test program should also include inspection/calibration of grout pump equipment and observation of augering/installation of indicator piles.

ACP Pile Monitoring Program There are inherent uncertainties with pile integrity in ACIP pile installation. A quality control and testing program is essential to ensure the integrity of the piles. The recommended pile capacities are based on the conditions that all piles will be monitored by a qualified engineering firm retained by the owner and directly supervised by the geotechnical engineer. This monitoring provision is required by the International Building Code (IBC) 2012 and Georgia Special Inspection Guidelines in accordance with IBC2012.

Pile Integrity Testing: The risk of bulging and necking increases with the presence of very soft soil deposit. Terracon recommends the integrity for the auger cast piles be tested using thermal integrity profiling (TIP) in accordance with ASTM D7949.

TIP is a relatively new technology for assessing the quality of cast-in-place concrete foundations using the temperature field generated by curing cement. Fundamentally, a shortage of competent concrete such as necking is registered by relative cool regions while the presence of extra concrete such as bulging is registered by warm regions. TIP measures the concrete temperatures either by a thermal probe or by embedded thermal sensors in the concrete. The thermal probe requires an access tube filled with water be prepared for probing; the measured temperature can be profiled continuously along the pile; however, the testing time is not continuous and should be selected at peak temperature. The testing by embedded thermal sensors typically gets temperatures through deploying thermal sensors at different depths, measures the temperature continuously, and automatically detects the peak temperature. However, it sacrifices the sensors embedded in the concrete.

We recommend TIP testing be performed on all test piles and approximately 10 percent of the production piles. Terracon should select piles to be tested based on the conditions observed during installations as well as other considerations. The contractor shall prepare access tubes and install tubes along the center based on Terracon's selection of test piles.

Pile Spacing and Sequencing We recommend that center-center spacing between adjacent piles be maintained at least three (3) times the pile diameter. No reduction of axial pile capacity was considered for the group effect. Piles should not be installed less than 10 feet away from the nearest pile within 12 hours from its installation. The contractor should develop a sequencing plan to allow adequate grout setup before installing adjacent piles.

4.7 Pavements

We understand the proposed development will include driveways and parking area. This section presents thickness recommendations for asphalt concrete and Portland cement concrete pavements and general considerations for the pavement construction. Pavement thickness design is dependent upon:

- The traffic loads including traffic pattern and the service life of the pavement;
- Subgrade conditions including soil strength and drainage characteristics;
- Paving material characteristics;
- Climatic conditions of the region.

Traffic patterns and anticipated loading conditions are not available at this time. We anticipate traffic loads will be produced primarily by automobile traffic and a limited number of delivery and trash removal trucks.

We have provided two pavement section alternatives: light and heavy duty sections. The light duty section is constructed for the areas that receive only car traffic. The heavy duty section assumed 2 trash removal trucks per week. If heavier traffic loading is expected, the commercial building should be provided with the anticipated traffic loading information and allowed to review these pavement sections. A design life of 20 years was assumed to develop the total traffic used in thickness design. However, as typical for pavement, some maintenance repairs are typically required for a period of 7 to 10 years.

For the pavement support, the subgrade conditions can often be the overriding factor in pavement performance. The subgrade conditions will depend on the in-situ soils at the subgrade level, characteristics of fill material for the subgrade as well as the site preparation procedures.

The subgrade conditions will depend on the in-situ soils at the subgrade level, characteristics of fill material for the subgrade as well as site preparation procedures. Assuming that the site will receive more than two feet of fill to reach the finished subgrade elevations. The subgrade will be fill material. We recommend the fill material for the subgrade be relatively clean sands with percent fines less than 15 percent. A California Bearing Ratio (CBR) value of 8 has been estimated based on the in-situ soils at the site and typical imported fills available in this area.

Climatic conditions are considered in the design subgrade support value listed above and in the paving material characteristics. The recommended paving material characteristics, taken from the Georgia Department of Transportation's (GDOT) 2001 edition of *Standard Specifications for Construction of Transportation Systems,* are included for the asphalt concrete sections.

4.7.1 Flexible (Asphalt) Pavement Design Recommendations

Material	**Minimum Section Thickness** (inch)		
	Light Duty Section	**Heavy Duty Section**	
	Auto Parking	**Access Road for Delivery / Trash Collection Vehicles**	**Concentrated and Repetitive Loading Areas (e.g. Dumpster pad, truck delivery docks and ingress/egress aprons)**
Asphalt Surface Course[1]	2	1 ½	We recommend concrete pavement sections for concentrated and repetitive loading areas, as concrete pavement, in general, performs better in these areas. Please refer to **Section 4.7.2** for the pavement section.
Asphalt Intermediate Course[1]	0	2	
Graded Aggregate Base Course[1]	7	8	
Total Pavement Section	**9**	**11 ½**	
Select fill[2] / improved subgrade[3]	24	24	

1. Asphalt concrete and base course materials should conform to the following GDOT material specifications.
   - Section 815 for Graded Aggregate
   - Section 828 for Hot Mix Asphalt Concrete Mixture. Surface course may use 9.5 mm Superpave for a smooth surface in the light-duty section or 12.5 mm Superpave for the heavy-duty section. 19 mm and/or 25 mm Superpave is recommended for the intermediate course.
2. The select fill should be relatively clean sands with percent fines less than 15% and should be compacted to a minimum of 95% of the soil's Modified Proctor maximum dry density (ASTM D-1557).
3. If SP or SP-SM or SM soils exist at the proposed subgrade elevation extending to a depth at least 24 inches below the proposed subgrade level, the in-situ soils can replace the select fill and the subgrade should be improved using densification as discussed in **Section 4.3.**

Notes:

- Proper surface and subgrade drainage system should be installed to avoid the saturation of subgrade soils underneath the asphalt pavements and should be designed to maintain the groundwater at least 2 feet below the top of the subgrade.
- We anticipate some subgrade soil undercutting and backfilling with suitable structural fill will be required if unstable subgrade soils are encountered during the subgrade preparation. The use of geogrid (Tensar BX1100 or equivalent) may be necessary to help reduce the depth of undercut to achieve stability if the unstable subgrade soils extend to greater depths. The need for geogrid and/or the need for undercutting and backfilling should be determined in the field during subgrade preparation.

4.7.2 Rigid (Concrete) Pavement Design Recommendations

Material	Minimum Section Thickness (inch)		
	Light Duty Section	Heavy Duty Section	
	Auto Parking	Access Road for Delivery / Trash Collection Vehicles	Concentrated and Repetitive Loading Areas (e.g. Dumpster pad, truck delivery docks and ingress/egress aprons)
Concrete[1]	5	7	7
Graded aggregate base[2]	0	0	0
Select fill[3] / improved subgrade[4]	24	24	24

1. The concrete should be air entrained and have a minimum compressive strength of 4,000 psi after 28 days of lab curing per ASTM C-31.
2. The graded aggregate base should conform to the GDOT material specification Section 815.
3. The select fill should be relatively clean sands with percent fines less than 15%. The fill material should be compacted to a minimum of 95% of the soil's Modified Proctor maximum dry density (ASTM D-1557).
4. If SP or SP-SM or SM soils exist at the proposed subgrade elevation extending to a depth at least 24 inches below the proposed subgrade level, the in-situ soils can replace the select fill and the subgrade should be improved using densification as discussed in **Section 4.3.**

Notes:

- Concrete joints should be sealed properly to avoid the ingress of surface water into the subgrade soils. Proper surface and subgrade drainage system should be installed to avoid the saturation of subgrade soils underneath the concrete pavements. The site drainage should be designed to maintain the groundwater at least 2 feet below the top of the subgrade.
- Some subgrade soil undercutting and backfilling with suitable structural fill will be required if unstable subgrade soils are encountered during subgrade preparation. The use of geogrid (Tensar BX1100 or equivalent) may be necessary to help reduce the depth of undercut to achieve stability if the unstable subgrade soils extend to greater depths. The need for geogrid and/or the need for undercutting and backfilling should be determined in the field during subgrade preparation.

The above rigid and flexible pavement sections represent the minimum design thicknesses and, as such, periodic maintenance should be anticipated. Prior to the placement of the subbase (compacted structural fill), the pavement areas should be thoroughly proofrolled.

4.7.3 Pavement Construction Considerations

Pavement subgrades prepared early in the project should be carefully evaluated as the time for pavement construction approaches. We recommend the pavement areas be rough graded and then thoroughly proofrolled with a loaded tandem-axle dump truck.

Particular attention should be paid to the high traffic areas that were rutted and disturbed and to the areas where backfilled trenches are located. Areas, where unsuitable conditions are located, should be repaired by removing and replacing the materials with properly compacted fill. After proofrolling and repairing subgrade deficiencies, the entire subgrade should be scarified to a depth of 12 inches, and uniformly compacted to at least 95% of the materials' modified Proctor maximum dry density.

4.7.4 Pavement and Subgrade Drainage

Poor subgrade drainage is the most common cause of pavement failure. Pavement should be sloped to provide a rapid drainage of surface water. Water should not be allowed to pond on the pavement surface or adjacent to the pavement which would saturate the subgrade soils and weaken the subgrade support. We recommend the site drainage be designed to maintain the groundwater at least two (2) feet below the top of the subgrade.

Pavement subgrade drainage should be installed surrounding the areas anticipated for frequent wetting or having poor natural drainage, such as landscaped islands, along curbs and gutters and around drainage structures.

All landscaped areas in or adjacent to pavements should be sealed to reduce the moisture migration to subgrade soils. Subgrade drains should be installed with the pipe bottom at least two (2) feet below the top of the select fill. The civil engineer should decide the placement of the subgrade drains to avoid the saturation of pavement subgrade.

4.7.5 Pavement Maintenance

The performance of pavements will require regular maintenance. One key component of the maintenance is to minimize the infiltration of water into the pavement base and subgrade. Preventive maintenance should include crack and joint sealing and patching, as well as overall surface sealing and overlay. Additional engineering observation and evaluation is recommended prior to any major maintenance.

4.8 Seismic Considerations

4.8.1 Seismic Design Parameters

According to the International Building Code (IBC) 2012 and ASCE 7-10, structures should be designed and constructed to withstand the effects of earthquakes and avoid failure during a maximum considered earthquake. The maximum considered earthquake (MCE) is a seismic event that has a 50-year exposure period with a 2% probability of exceedance. The 2500-year earthquake has a Moment Magnitude (Mw) of 7.3 and a Site Class Adjusted Peak Ground Acceleration (PGA_M) of 0.24g, as determined by data provided by the IBC 2012 and ASCE 7-10 Standards.

Based on the findings in the field exploration and our knowledge of the local geological formation in the project area, the site can be classified as Site Class D in accordance with

International Building Code (IBC) 2012 and ASCE 7-10. The seismic design parameters obtained based on IBC2012 and ASCE 7-10 are summarized in table below. The design response spectrum curve, as presented in the appendix, was developed based on the S_{DS} and S_{D1} values according to IBC2012 and ASCE 7-10.

Table 4.8.1.1 Summary of Seismic Design Parameters

Site Location (Latitude. Longitude.)	**Site Classification**	S_s	S_1	F_a	F_v	S_{DS}	S_{D1}
32.1131° -81.1963°	D	0.302g	0.118g	1.558	2.329	0.314g	0.183g

- The IBC 2012 and ASCE 7-10 require a seismic Site Class determination based on the soils in the upper 100 feet. The current scope of work for this project included a field exploration to a maximum depth of 70 feet BGS. The seismic Site Class was determined based on the results of the field exploration and our knowledge of the geologic conditions of the site area.

5.0 GENERAL COMMENTS

Terracon should be consulted to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the project design and specifications. Terracon should also be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analyses and recommendations presented in this report are based upon the data obtained from the explorations performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between exploration locations, across the site, or may be caused due to the modifying effects of construction or weather. Bear in mind that the nature and extent of such variations may not become evident until construction has started or until construction activities have ceased.

If variations do appear, Terracon should be notified immediately so that further evaluation and supplemental recommendations can be provided. The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or hazardous conditions. If the owner is concerned about the potential for such contamination or pollution, please advise so that additional studies may be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project and site discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes, and then either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

Image Courtesy of
Google Earth™

Project Manager:	YJ	Project No.	ES185011
Drawn by:	YJ	Scale:	N.T.S.
Checked by:	GL	File Name:	
Approved by:	GL	Date:	2/16/18

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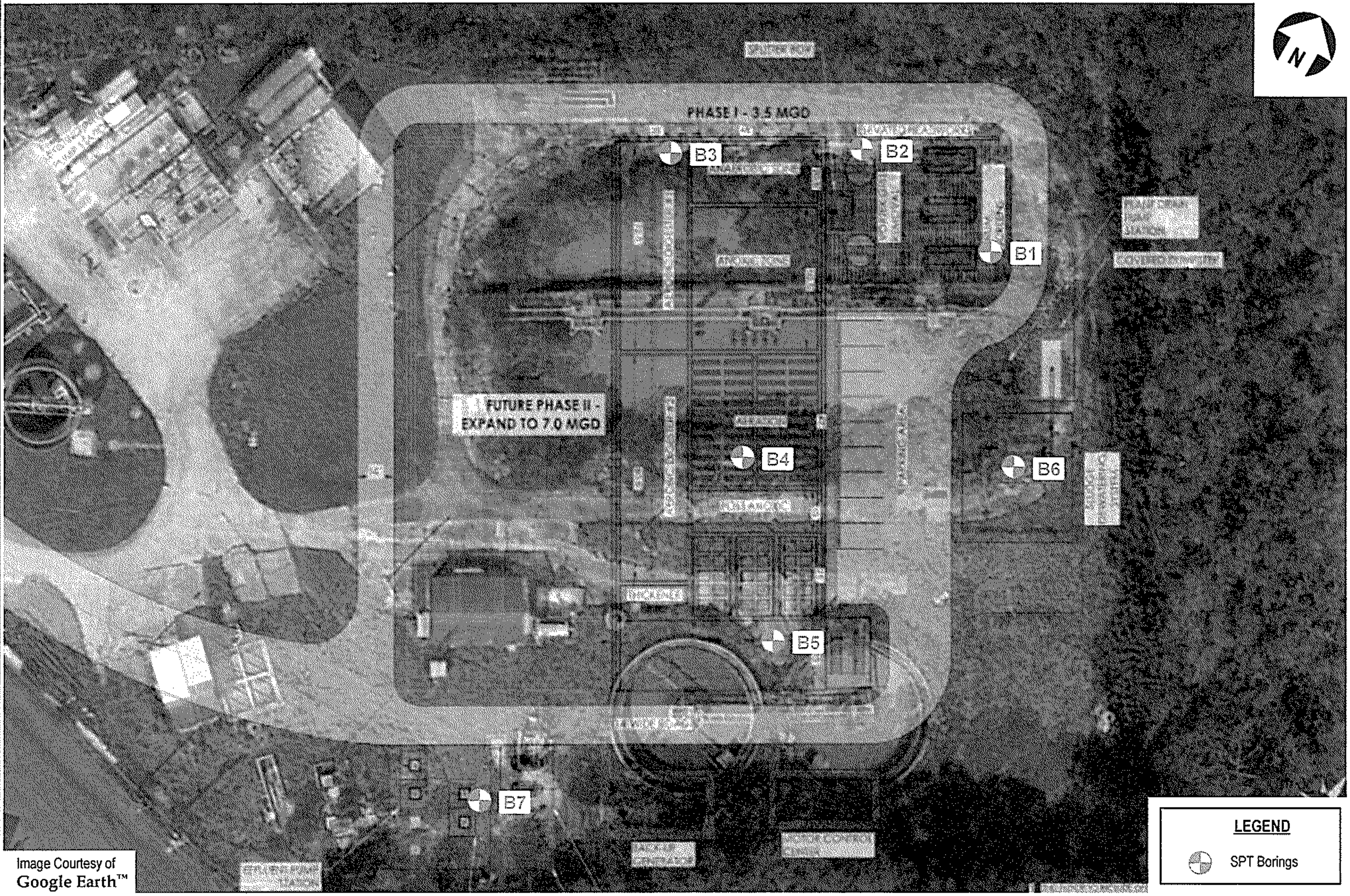
SITE LOCATION MAP

Travis Field WWTF
Savannah
Chatham County, Georgia

Exhibit:
A-1



NOTES:

ALL EXPLORATION LOCATIONS WERE LOCATED IN THE FIELD USING A GPS UNIT AND / OR SITE LANDMARKS. EXPLORATION LOCATIONS SHOULD BE CONSIDERED APPROXIMATE. DIAGRAM IS FOR GENERAL LOCATION ONLY; NOT INTENDED FOR CONSTRUCTION PURPOSES.

Project Manager:	YJ	Project No.	ES185011
Drawn by:	YJ	Scale:	N.T.S.
Checked by:	GL	File Name:	
Approved by:	GL	Date:	2/16/18

Terracon
Consulting Engineers & Scientists
2201 Rowland Avenue Savannah, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

EXPLORATION LOCATION PLAN

Travis Field WWTF
Savannah
Chatham County, Georgia

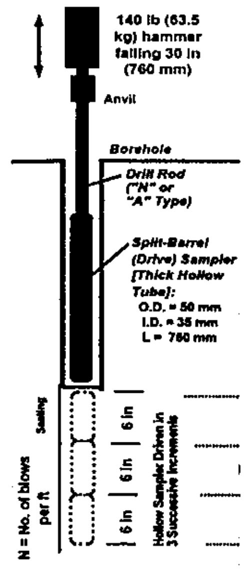
Exhibit: A-2

Field Exploration Description

The locations of Standard Penetration Test (SPT) and hand auger borings are determined by Terracon based on the proposed plan and were located in the field using a hand-held GPS unit and in reference to the existing features. These locations are shown in the Exploration Location Plan in **Exhibit A-2** and should be considered approximate.

Standard Penetration Testing

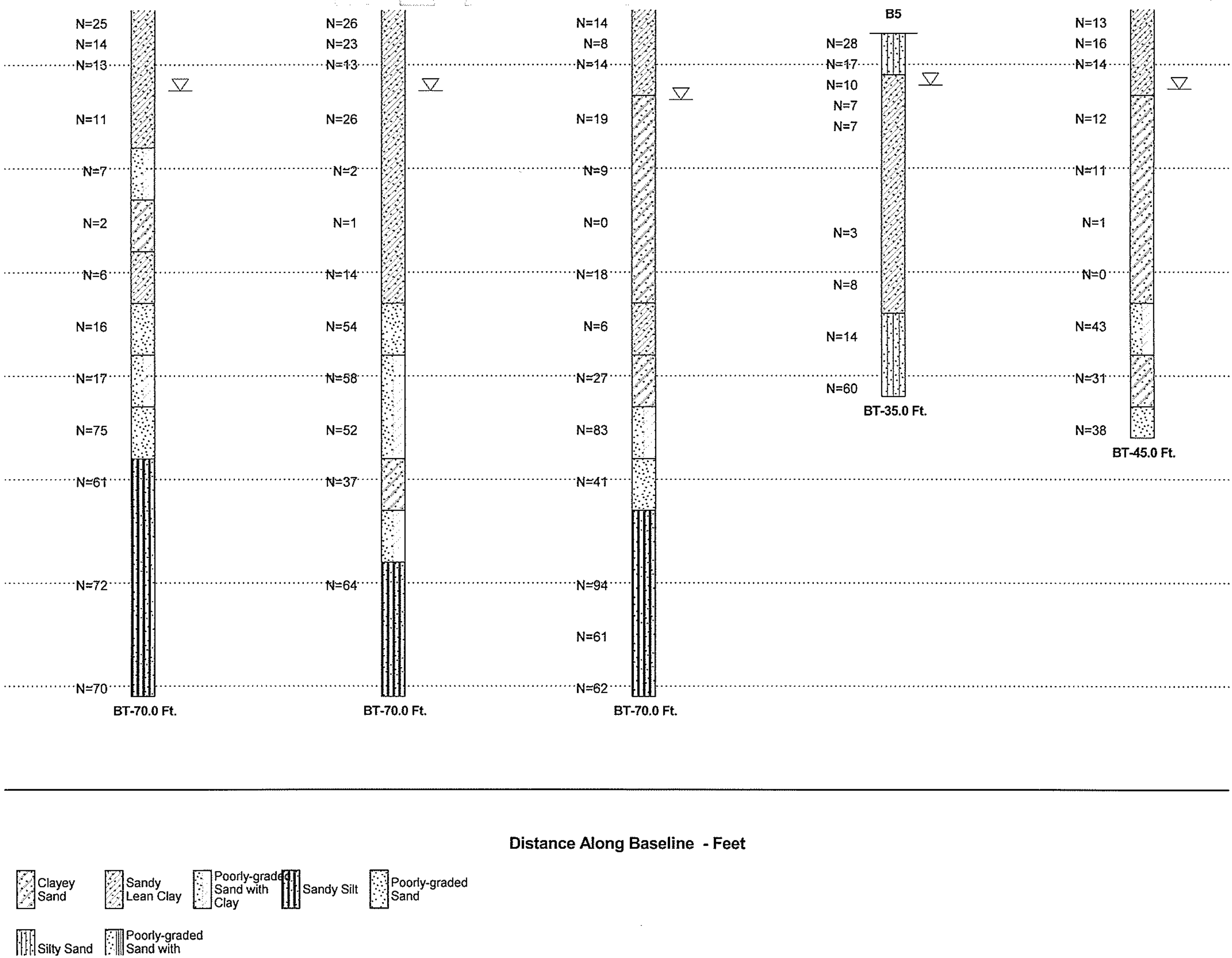
The SPT borings were performed in accordance with ASTM D1586 with a trailer-mounted CME drilling rig using mud rotatory drilling techniques. Samples of the soil encountered in the borings were obtained using split-barrel sampling procedures. In the split barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in situ relative density of cohesionless soils and consistency of cohesive soils. A rope and cathead hammer was used to advance the split-barrel sampler in the borings performed on this site.



Source: FHWA NHI-06-088

Hand Auger Borings

Hand auger borings were conducted in general accordance with ASTM D 1452-80, Standard Practice for Soil Investigation and Sampling by Auger Borings. In this test, hand auger borings are drilled by rotating and advancing a bucket auger to the desired depths while periodically removing the auger from the hole to clear and examine the auger cuttings. The soils were classified in accordance with ASTM D2488.



N=25
N=14
N=13
N=11
N=7
N=2
N=6
N=16
N=17
N=75
N=61
N=72
N=70
BT-70.0 Ft.
N=26
N=23
N=13
N=26
N=2
N=1
N=14
N=54
N=58
N=52
N=37
N=64
BT-70.0 Ft.
N=14
N=8
N=14
N=19
N=9
N=0
N=18
N=6
N=27
N=83
N=41
N=94
N=61
N=62
BT-70.0 Ft.
B5
N=28
N=17
N=10
N=7
N=7
N=3
N=8
N=14
N=60
BT-35.0 Ft.
N=13
N=16
N=14
N=12
N=11
N=1
N=0
N=43
N=31
N=38
BT-45.0 Ft.
Distance Along Baseline - Feet
Clayey Sand
Sandy Lean Clay
Poorly-graded Sand with Clay
Sandy Silt
Poorly-graded Sand
Silty Sand
Poorly-graded Sand with

BORING LOG NO. B1

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton
Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1135° Longitude: -81.1861°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	CLAYEY SAND (SC), fine grained, dark gray and brown and orange, dense				X	13-18-19-13 N=37
2.0		17+/-				
	SANDY LEAN CLAY (CL), with mulch, gray and orange, very stiff				X	8-16-13-13 N=29
	with some shell fragments and mulch, dark bluish gray, very stiff		5		X	8-8-11-11 N=19
	dark bluish gray and brown, very stiff				X	13-12-7-9 N=19
	gray and orange, stiff		10		X	15-9-7-9 N=16
12.0		7+/-		▽		
	CLAYEY SAND (SC), fine to medium grained, brown and dark gray, medium dense		15		X	12-5-5 N=10
	with shell fragments, fine to coarse grained, dark gray, loose		20		X	15-6-1 N=7
	fine grained, gray, very loose		25		X	0-0-0 N=0
27.0		-8+/-				
	SANDY LEAN CLAY (CL), dark gray, soft		30		X	0-0-2 N=2
32.0		-13+/-				
	POORLY GRADED SAND WITH CLAY (SP-SC), fine to medium grained, dark gray, dense		35		X	16-15-21 N=36
	dark gray, very dense		40		X	18-28-24 N=52

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-10-2018	Boring Completed: 02-10-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-1

BORING LOG NO. B1

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton, Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1135° Longitude: -81.1861°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	POORLY GRADED SAND WITH CLAY (SP-SC), fine to medium grained, dark gray, dense *(continued)*					
	dark gray, very dense		45		X	34-36-50/4"
47.0		-28+/-				
	SANDY SILT (ML), fine grained, dark gray and olive green, hard		50		X	21-23-28 N=51
	fine grained, dark gray and olive green, hard		55		X	35-43-50/5"
	fine grained, dark gray and olive green, hard		60		X	30-35-44 N=79
	fine grained, dark gray and olive green, hard		65		X	50/5"
70.0	fine grained, dark gray and olive green, hard	-51+/-	70		X	21-26-38 N=64
	Boring Terminated at 70 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-10-2018	Boring Completed: 02-10-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-1

BORING LOG NO. B2

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1134° Longitude: -81.1864°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	SANDY LEAN CLAY (CL), gray and orange, stiff				X	12-8-8-13 N=16
	dark gray and orange, very stiff				X	9-11-9-9 N=20
	dark gray and orange, very stiff		5		X	9-12-13-10 N=25
	dark gray and orange, stiff				X	9-7-7-7 N=14
	dark gray and orange, stiff		10		X	6-7-6-6 N=13
				▽		
	dark gray and orange, stiff		15		X	10-5-6 N=11
17.0		2+/-				
	POORLY GRADED SAND WITH CLAY (SP-SC), fine grained, gray, loose		20		X	5-4-3 N=7
22.0		-3+/-				
	CLAYEY SAND (SC), fine grained, dark gray, very loose		25		X	0-0-2 N=2
27.0		-8+/-				
	SANDY LEAN CLAY (CL), dark gray, medium stiff		30		X	6-3-3 N=6
32.0		-13+/-				
	POORLY GRADED SAND (SP), fine to medium grained, dark gray, medium dense		35		X	23-6-10 N=16
37.0		-18+/-				
	POORLY GRADED SAND WITH CLAY (SP-SC), fine to coarse grained, dark gray, medium dense		40		X	14-7-10 N=17

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-09-2018	Boring Completed: 02-09-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-2

BORING LOG NO. B2

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton
Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1134° Longitude: -81.1864°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
42.0	POORLY GRADED SAND WITH CLAY (SP-SC), fine to coarse grained, dark gray, medium dense *(continued)*	-23+/-				
	POORLY GRADED SAND (SP), fine to medium grained, dark gray, very dense		45		X	41-38-37 N=75
47.0		-28+/-				
	SANDY SILT (ML), dark gray and olive green, hard		50		X	22-31-30 N=61
	dark gray and olive green, hard		55		X	50/5"
	No Recovery		60		X	41-49-23 N=72
	dark gray and olive green, hard		65		X	40-45-50/5"
70.0	dark gray and olive green, hard	-51+/-	70		X	30-36-34 N=70
	Boring Terminated at 70 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

After 24 hours

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-09-2018	Boring Completed: 02-09-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-2

BORING LOG NO. B3

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1134° Longitude: -81.1866°

Approximate Surface Elev: 19 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	SANDY LEAN CLAY (CL), gray and orange, stiff				X	8-7-8-8 N=15
	No Recovery				X	11-11-11-10 N=22
	brown and gray, very stiff		5		X	14-15-11-13 N=26
	gray and orange, very stiff				X	11-11-12-8 N=23
	gray and orange, stiff				X	8-6-7-11 N=13
			10	▽		
	gray, very stiff		15		X	8-12-14 N=26
	gray, very soft to soft		20		X	5-1-1 N=2
	gray, very soft		25		X	0-0-1 N=1
	gray, stiff		30		X	8-8-6 N=14
	32.0	-13+/-				
	POORLY GRADED SAND (SP), fine to coarse grained, gray, very dense		35		X	21-26-28 N=54
	37.0	-18+/-				
	POORLY GRADED SAND WITH CLAY (SP-SC), fine to coarse grained, gray, very dense		40		X	21-28-30 N=58

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method: Mud Rotary	See Exhibit A-3 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any).	Notes:
Abandonment Method:	See Appendix C for explanation of symbols and abbreviations.	

WATER LEVEL OBSERVATIONS	Terracon 2201 Rowland Ave Savannah, GA	Boring Started: 02-09-2018	Boring Completed: 02-09-2018
▽ *After 24 hours*		Drill Rig: BR-2500	Driller: Josh & Matt
		Project No.: ES185011	Exhibit: A-3

BORING LOG NO. B3

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1134° Longitude: -81.1866°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	POORLY GRADED SAND WITH CLAY (SP-SC), fine to coarse grained, gray, very dense *(continued)*					
	fine to coarse grained, gray, very dense		45		X	8-26-26 N=52
47.0		-28+/-				
	CLAYEY SAND (SC), fine grained, gray, hard		50		X	12-13-24 N=37
52.0		-33+/-				
	POORLY GRADED SAND WITH CLAY (SP-SC), fine grained, gray, very dense		55		X	50/5"
57.0		-38+/-				
	SANDY SILT (ML), dark gray and olive green, hard		60		X	25-28-36 N=64
	dark gray and olive green, hard		65		X	31-37-50/4"
	dark gray and olive green, hard				X	22-50/5"
70.0		-51+/-	70			
	Boring Terminated at 70 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.

Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-09-2018	Boring Completed: 02-09-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-3

BORING LOG NO. B4

PROJECT: Travis Field WWTF | **CLIENT: Thomas & Hutton, Savannah, GA**

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1131° Longitude: -81.1863°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	SANDY LEAN CLAY (CL), dark gray and brown, stiff				X	13-8-6-6 N=14
	gray and orange, very stiff				X	7-11-13-11 N=24
	dark gray and brown, stiff		5		X	6-8-6-6 N=14
	dark gray and brown, medium stiff				X	6-4-4-7 N=8
	gray and orange, stiff		10		X	14-7-7-10 N=14
12.0		7+/-		▽		
	CLAYEY SAND (SC), fine grained, gray and orange, medium dense		15		X	12-11-8 N=19
	fine grained, gray and orange, loose		20		X	6-5-4 N=9
	with some mulch, fine grained, gray, very loose		25		X	0-0-0 N=0
	fine grained, dark gray, medium dense		30		X	0-10-8 N=18
32.0		-13+/-				
	SANDY LEAN CLAY (CL), dark gray, medium stiff		35		X	1-3-3 N=6
37.0		-18+/-				
	CLAYEY SAND (SC), fine to medium grained, dark gray, medium dense		40		X	9-16-11 N=27

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-10-2018	Boring Completed: 02-10-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-4

BORING LOG NO. B4

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton
Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1131° Longitude: -81.1863°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	CLAYEY SAND (SC), fine to medium grained, dark gray, medium dense *(continued)*					
42.0		-23+/-				
	POORLY GRADED SAND WITH CLAY (SP-SC), fine to coarse grained, dark gray, very dense		45		X	36-48-35 N=83
47.0		-28+/-				
	POORLY GRADED SAND (SP), fine to coarse grained, dark gray, very dense		50		X	38-21-20 N=41
52.0		-33+/-				
	SANDY SILT (ML), fine grained, dark gray and olive green, hard		55		X	38-50/4"
	dark gray and olive green, hard		60		X	40-44-50 N=94
	dark gray and olive green, hard		65		X	23-28-33 N=61
	dark gray and olive green, hard				X	25-24-38 N=62
70.0		-51+/-	70			
	Boring Terminated at 70 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS
▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-10-2018	Boring Completed: 02-10-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-4

BORING LOG NO. B5

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.113° Longitude: -81.1862°

Approximate Surface Elev: 13 (Ft.) +/-

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
		SILTY SAND (SM), fine grained, brown, dense				X	10-14-14-18 N=28
		trace shell fragments, brown, medium dense			▽ (after 24 hours)	X	11-10-7-6 N=17
	4.0		9+/-				
		SANDY LEAN CLAY (CL), gray and brown, stiff		5	▽ (while drilling)	X	5-4-6-6 N=10
		gray and brown, medium stiff				X	4-3-4-3 N=7
		gray and brown, medium stiff		10		X	3-3-4-3 N=7
		wood stump, No Recovery		15			50/1"
		light gray, soft		20		X	3-1-2 N=3
		with nodules quartz pebbles, gray, medium stiff		25		X	5-5-3 N=8
	27.0		-14+/-				
		SILTY SAND (SM), fine to coarse grained, light gray, medium dense		30		X	10-6-8 N=14
		very dense				X	32-28-32 N=60
	35.0		-22+/-	35			
		Boring Terminated at 35 Feet					

Stratification lines are approximate. In-situ, the transition may be gradual.

Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-11-2018	Boring Completed: 02-11-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-5

BORING LOG NO. B6

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton
Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1132° Longitude: -81.186°

Approximate Surface Elev: 19 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	SANDY LEAN CLAY (CL), gray and brown, very stiff				X	17-11-12-16 N=23
	with shell fragments, gray and orange, very stiff				X	11-10-11-15 N=21
	gray and orange and green, stiff		5		X	11-8-5-6 N=13
	gray and orange, stiff				X	14-5-11-10 N=16
	gray and orange, stiff		10	▽	X	11-8-6-6 N=14
12.0		7+/-				
	CLAYEY SAND (SC), fine grained, gray and orange, medium dense		15		X	17-8-4 N=12
	fine grained, gray and orange, medium dense		20		X	8-7-4 N=11
	fine grained, dark gray, very loose		25		X	0-0-1 N=1
	fine grained, dark gray, very loose		30		X	0-0-0 N=0
32.0		-13+/-				
	POORLY GRADED SAND WITH CLAY (SP-SC), fine to medium grained, dark gray, dense		35		X	45-21-22 N=43
37.0		-18+/-				
	CLAYEY SAND (SC), fine to medium grained, dark gray, dense		40		X	15-15-16 N=31

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method: Mud Rotary	See Exhibit A-3 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any).	Notes:
Abandonment Method:	See Appendix C for explanation of symbols and abbreviations.	

WATER LEVEL OBSERVATIONS			
▽ *After 24 hours*	Terracon 2201 Rowland Ave Savannah, GA	Boring Started: 02-10-2018	Boring Completed: 02-10-2018
		Drill Rig: BR-2500	Driller: Josh & Matt
		Project No.: ES185011	Exhibit: A-6

BORING LOG NO. B6

PROJECT: Travis Field WWTF	**CLIENT:** Thomas & Hutton Savannah, GA
SITE: Savannah, Georgia	

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.1132° Longitude: -81.186° Approximate Surface Elev: 19 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	CLAYEY SAND (SC), fine to medium grained, dark gray, dense *(continued)* 42.0 -23+/-				
	POORLY GRADED SAND (SP), fine to medium grained, dark gray, dense 45.0 -26+/-	45		X	20-16-22 N=38
	Boring Terminated at 45 Feet				

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method: Mud Rotary	See Exhibit A-3 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any).	Notes:
Abandonment Method:	See Appendix C for explanation of symbols and abbreviations.	

WATER LEVEL OBSERVATIONS			
▽ *After 24 hours*	Terracon 2201 Rowland Ave Savannah, GA	Boring Started: 02-10-2018	Boring Completed: 02-10-2018
		Drill Rig: BR-2500	Driller: Josh & Matt
		Project No.: ES185011	Exhibit: A-6

BORING LOG NO. B7

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton
Savannah, GA

SITE: Savannah, Georgia

LOCATION See Exhibit A-2

Latitude: 32.1128° Longitude: -81.1863°

Approximate Surface Elev: 11.8 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	SILTY SAND (SM), brown				X	13-11-8-11 N=19
	with broken brick fragments, brown				X	8-10-12-8 N=22
4.0		8+/-				
	SANDY LEAN CLAY (CL), brown		5	▽	X	15-14-14-10 N=28
	brown				X	12-8-8-8 N=16
	gray and brown				X	10-7-7-7 N=14
			10			
	gray and brown and orange				X	6-2-2 N=4
			15			
17.0		-5+/-				
	CLAYEY SAND (SC), light gray				X	1-2-1 N=3
			20			
	light gray				X	4-2-3 N=5
			25			
27.0		-15+/-				
	POORLY GRADED SAND WITH SILT (SP-SM), fine to medium grained, light gray				X	20-22-21 N=43
			30			
	fine to medium grained, light gray				X	26-27-19 N=46
			35			
37.0		-25+/-				
	SANDY SILT (ML), fine grained, dark gray and olive green, hard				X	15-19-21 N=40
			40			

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

▽ *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-11-2018	Boring Completed: 02-11-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-7

BORING LOG NO. B7

PROJECT: Travis Field WWTF

CLIENT: Thomas & Hutton Savannah, GA

SITE: Savannah, Georgia

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 32.1128° Longitude: -81.1863° Approximate Surface Elev: 11.8 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
	SANDY SILT (ML), fine grained, dark gray and olive green, hard *(continued)*				
	dark gray and olive green, hard			X	30-36-25 N=61
	45.0 -33+/-	45			
	Boring Terminated at 45 Feet				

Stratification lines are approximate. In-situ, the transition may be gradual.
Elevation was estimated based on Site Plan dated March 6, 2018 provided by Thomas & Hutton

Hammer Type: Rope and Cathead

Advancement Method:
Mud Rotary

Abandonment Method:

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

- *While drilling*
- *After 24 hours*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 02-11-2018	Boring Completed: 02-11-2018
Drill Rig: BR-2500	Driller: Josh & Matt
Project No.: ES185011	Exhibit: A-7

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL ES185011 TRAVIS FIELD WWTP.GPJ TERRACON_DATATEMPLATE.GDT 3/8/18

APPENDIX B
SUPPORTING INFORMATION

Seismic Design Parameters Based on IBC2012 Code and ASCE 7-10 Standard

Terracon Project Name: Travis Field WWTF
Terracon Project Number: ES185011

Site Location: Savannah, Georgia
Latitude : 32.1131
Longitude : -81.1963

Site Class: D

Design Response Spectrum for the Site Class

S_s 0.302	S_1 0.118
F_a 1.558	F_v 2.329
S_{MS} 0.471	S_{M1} 0.275
S_{DS} 0.314	S_{D1} 0.183

	Period (sec)	Sa (g)
	0.000	0.125
T_0	0.117	0.314
	0.200	0.314
T_S	0.584	0.314
T	0.700	0.262
	0.800	0.229
	0.900	0.204
	1.000	0.183
	1.100	0.167
	1.200	0.153
	1.300	0.141
	1.400	0.131
	1.500	0.122
	1.600	0.115
	1.700	0.108
	1.800	0.102
	1.900	0.096
	2.000	0.092

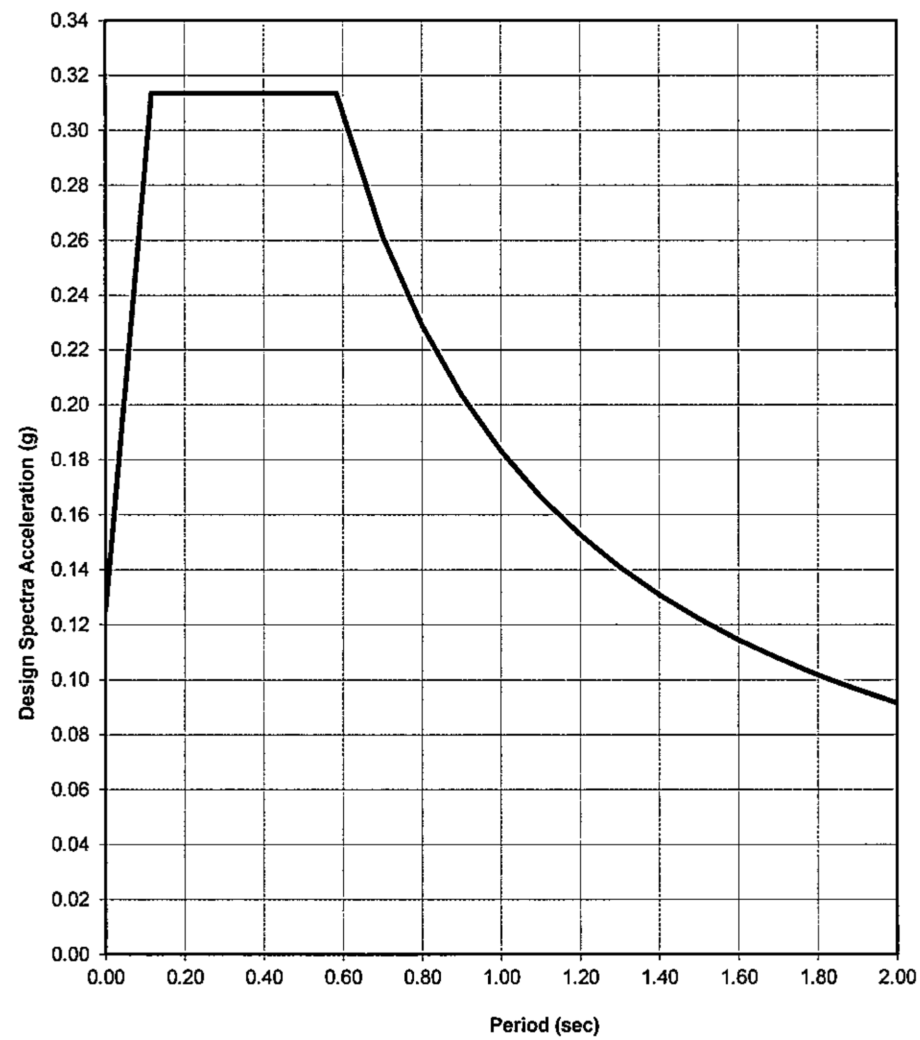
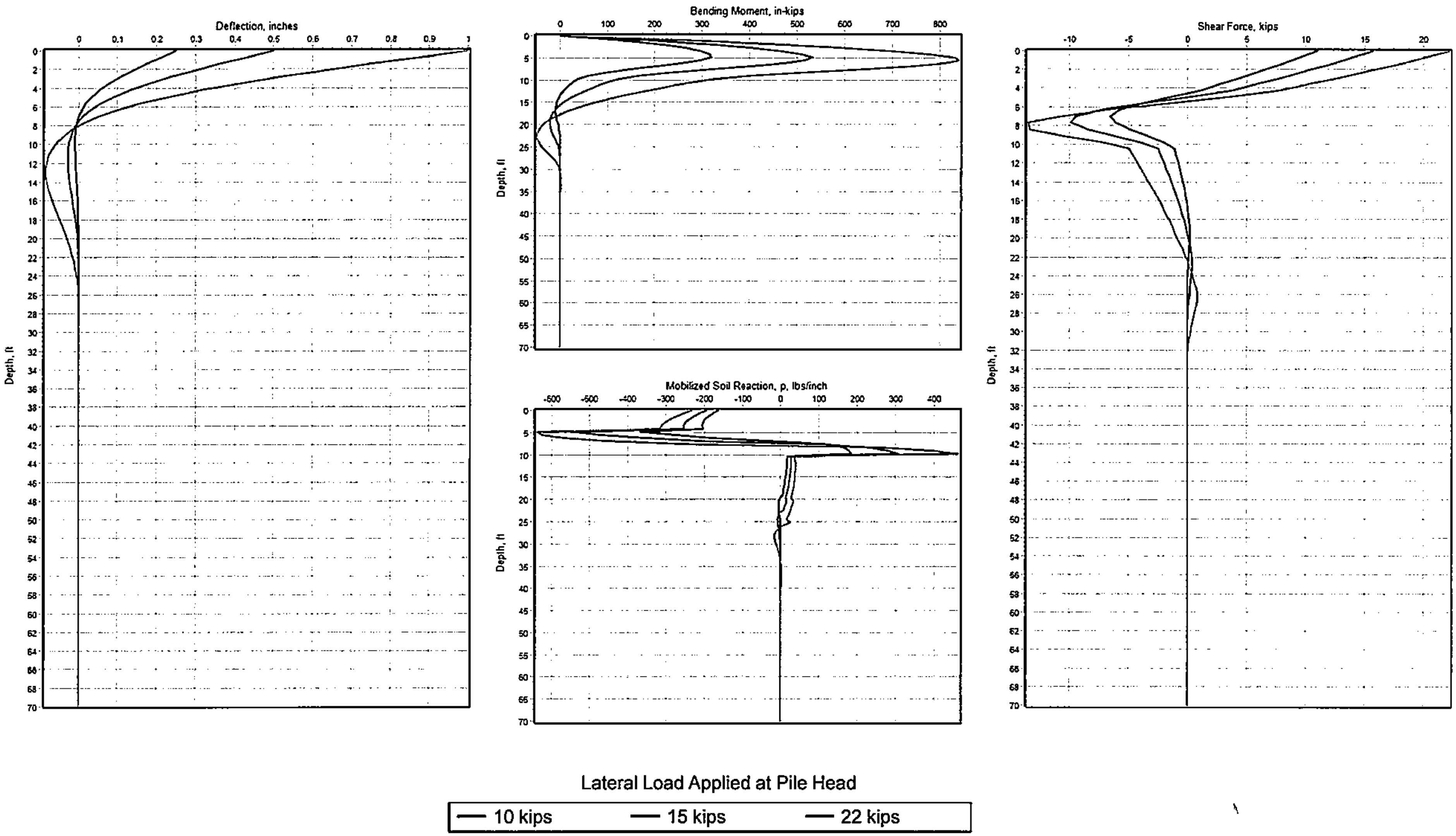


Exhibit B-1

12” PSC Piles, Static Loading, Free Head



Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011
Drawn by: YJ	Scale: N.T.S.
Checked by: GL	File Name:
Approved by: GL	Date: 3/7/2018

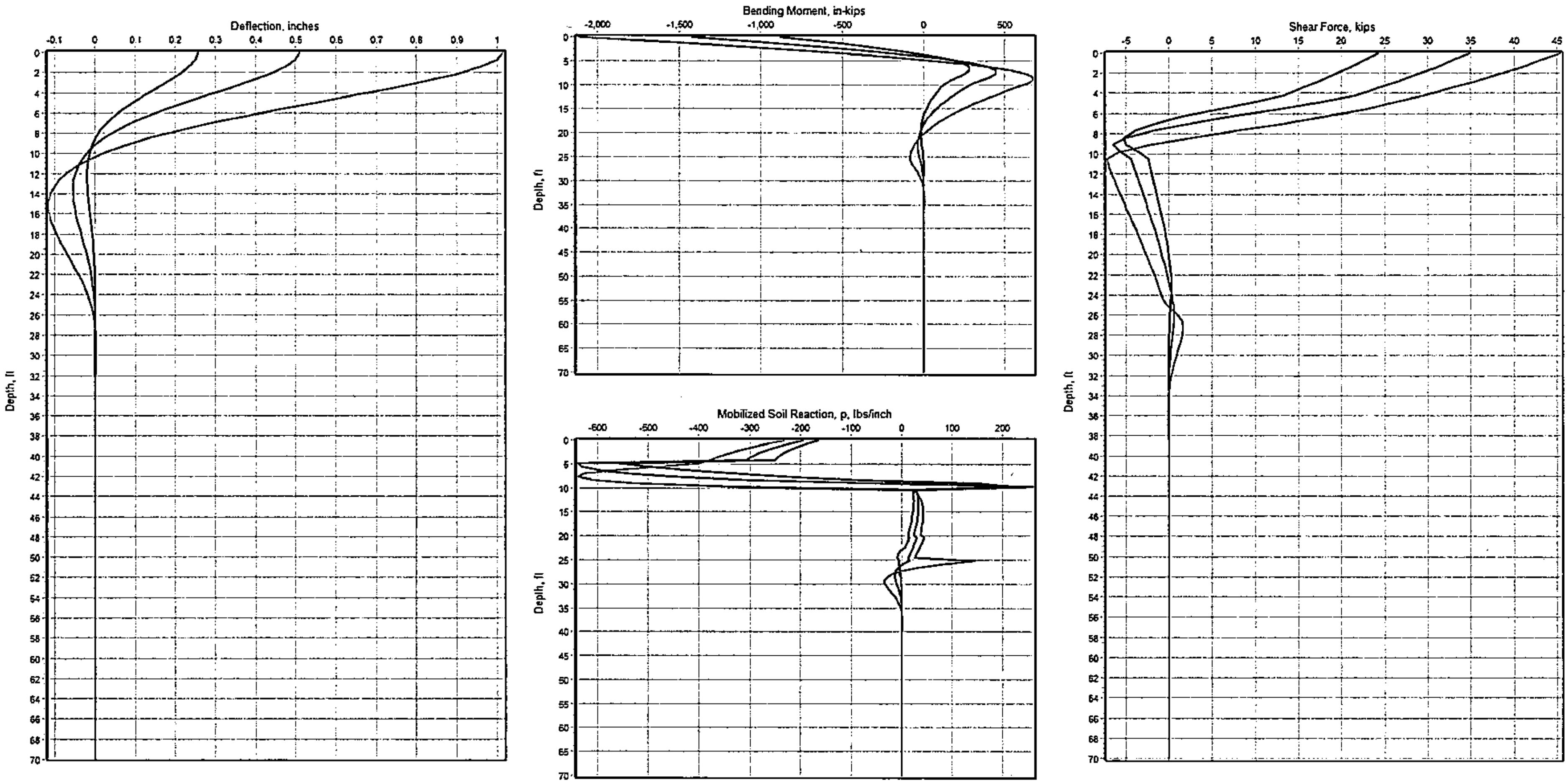
Terracon
Consulting Engineers & Scientists
2201 Rowland Avenue Savannah, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

LPILE Analyses

Travis Field WWTF
Savannah, Georgia

Figure
B-2-1

12" PSC Piles, Static Loading, Fixed Head



Lateral Load Applied at Pile Head

— 24 kips — 34 kips — 45 kips

Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011		
Drawn by: YJ	Scale: N.T.S.		
Checked by: GL	File Name:		
Approved by: GL	Date: 3/7/2018		

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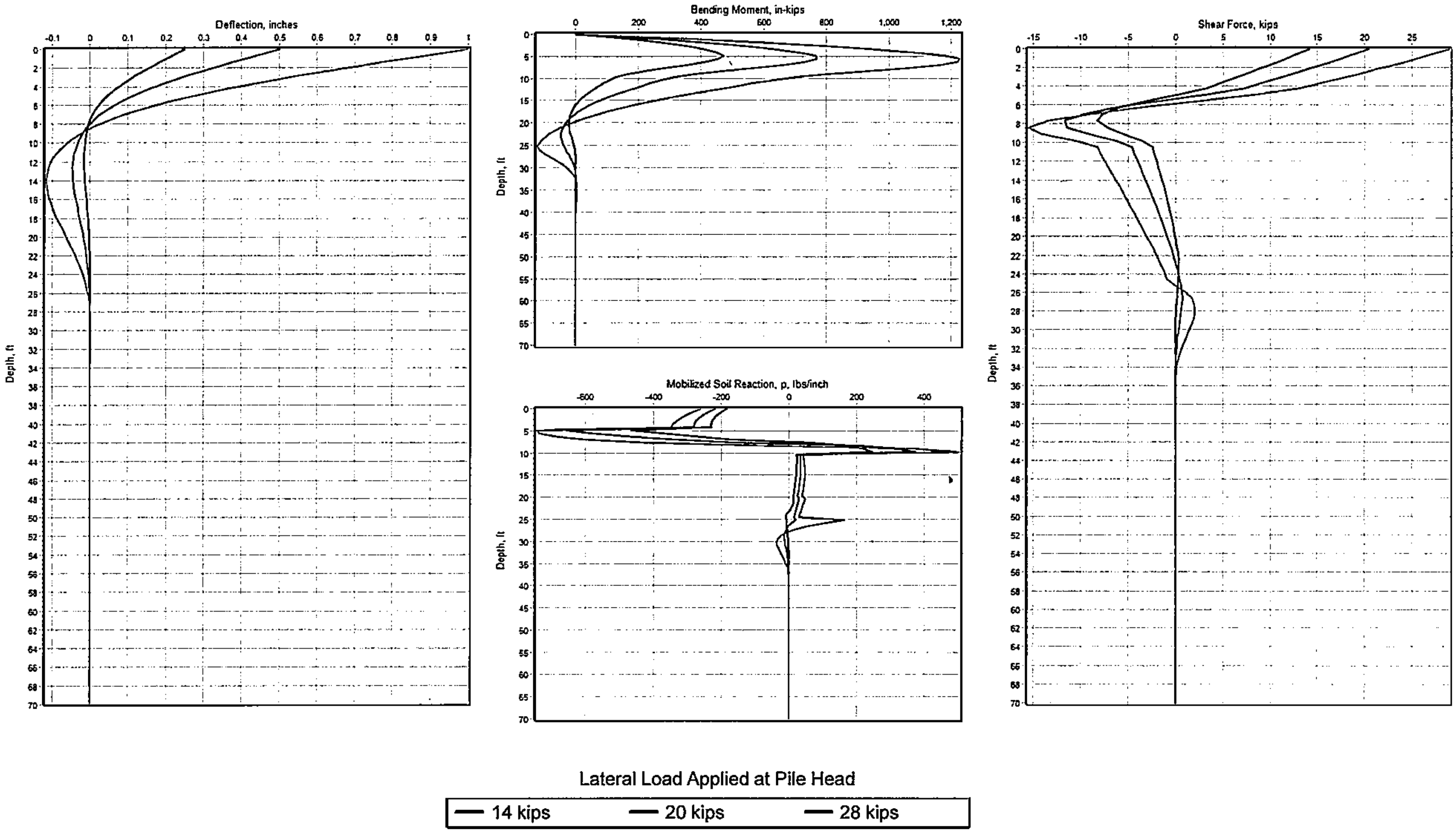
LPILE Analyses

Travis Field WWTF
Savannah, Georgia

Figure
B-2-2

14" PSC Piles, Static Loading, Free Head



Note:

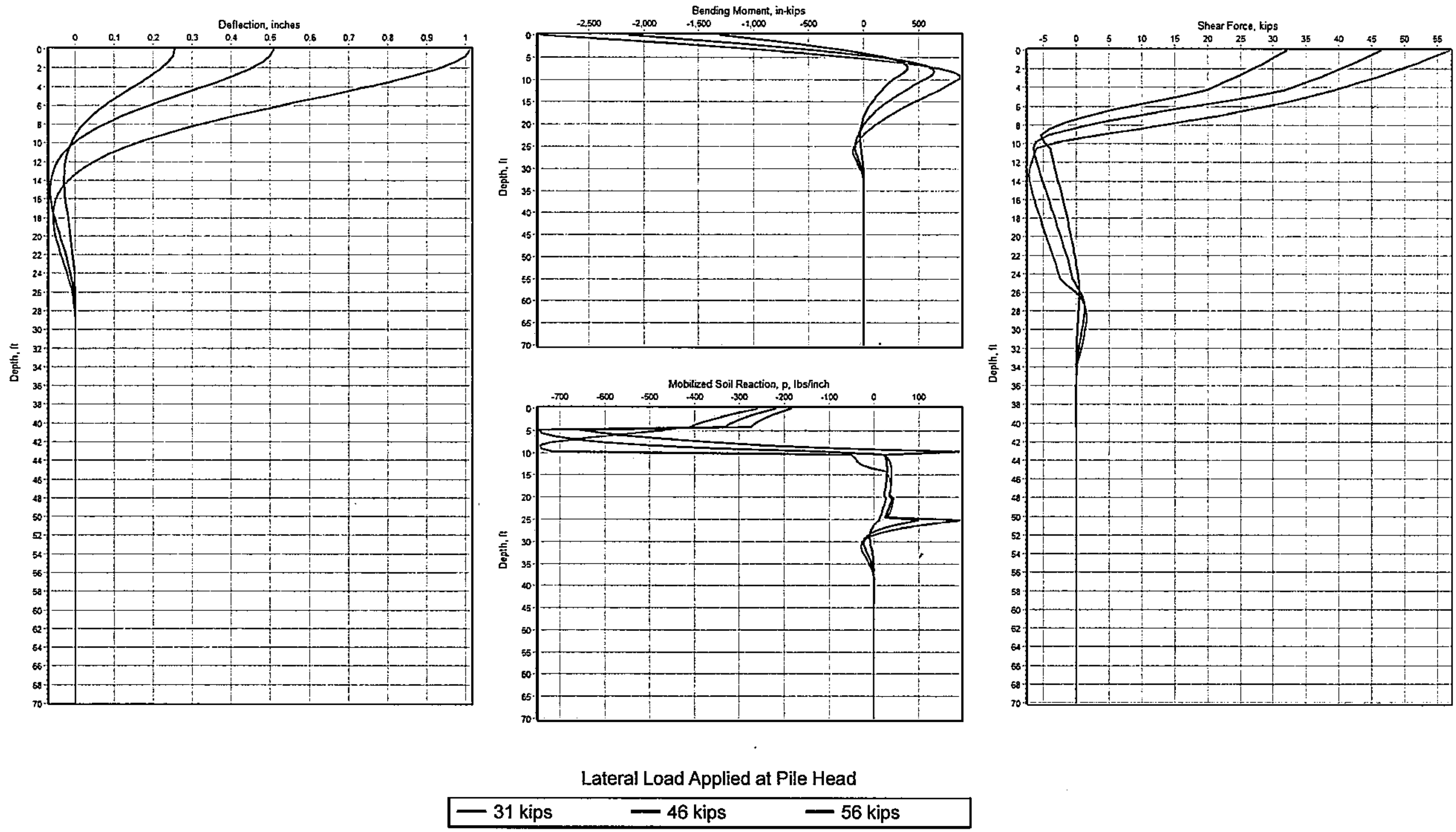
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011	Terracon Consulting Engineers & Scientists	LPILE Analyses
Drawn by: YJ	Scale: N.T.S.	2201 Rowland Avenue Savannah, Georgia 31404	Travis Field WWTF Savannah, Georgia
Checked by: GL	File Name:	Phone (912) 629 4000 Fax (912) 629 4001	
Approved by: GL	Date: 3/7/2018		

Figure

B-2-3

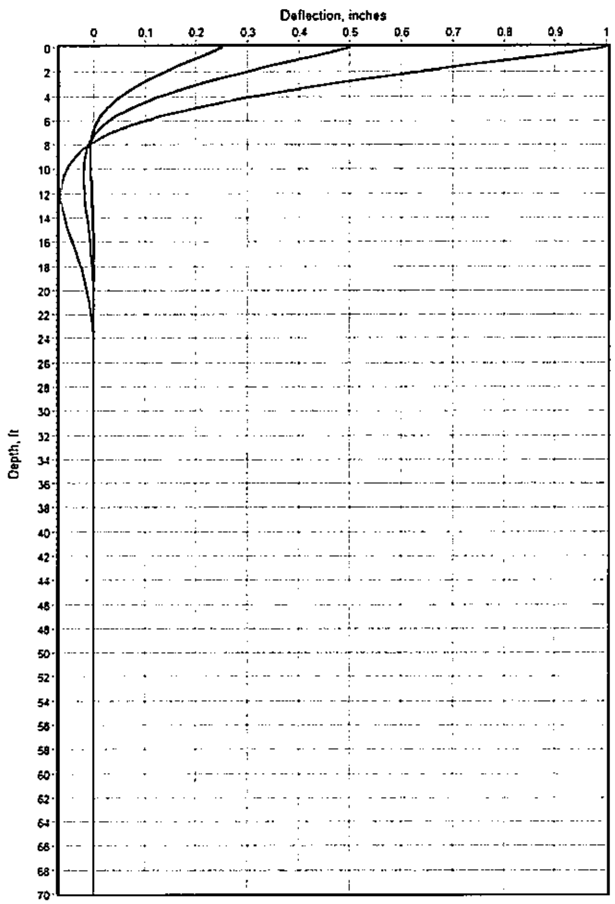
14" PSC Piles, Static Loading, Fixed Head

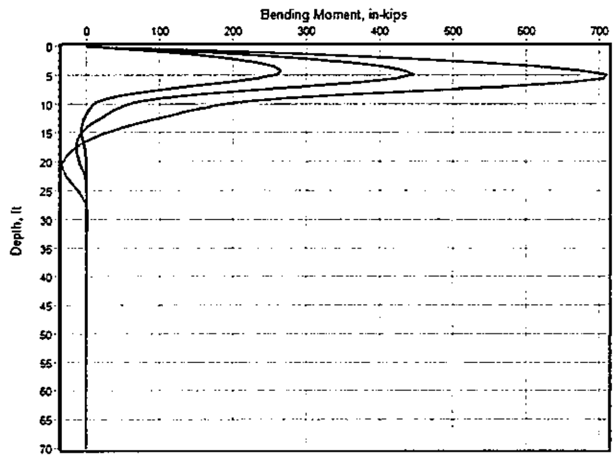


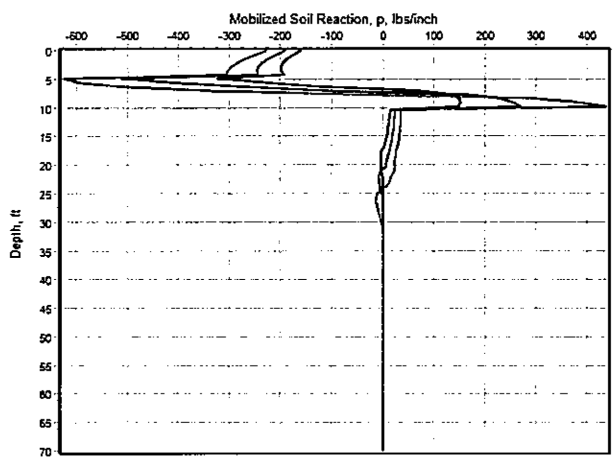
Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

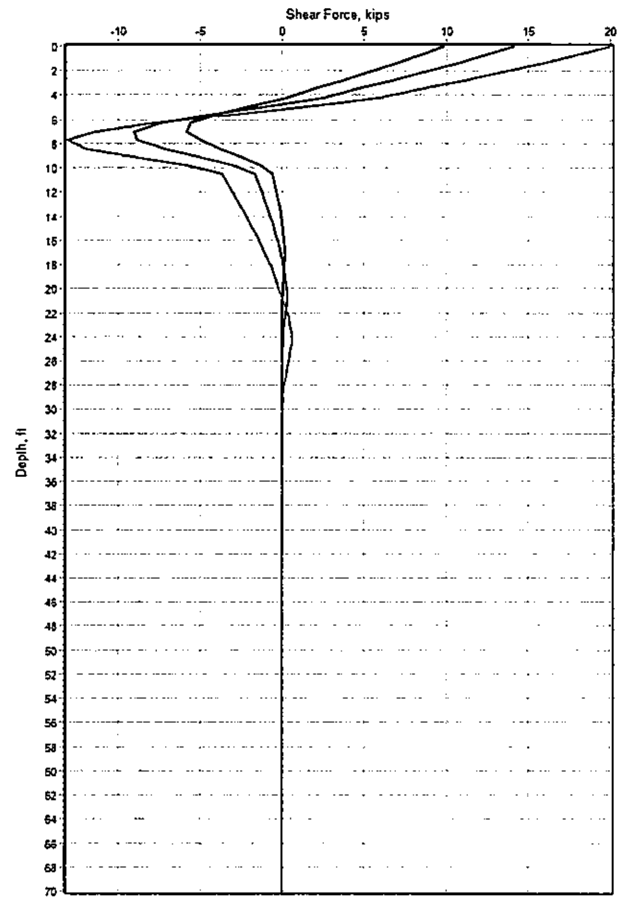
Project Manager: YJ	Project No. ES185011	Terracon Consulting Engineers & Scientists	LPILE Analyses
Drawn by: YJ	Scale: N.T.S.	2201 Rowland Avenue Savannah, Georgia 31404	Travis Field WWTF Savannah, Georgia
Checked by: GL	File Name:	Phone (912) 629 4000 Fax (912) 629 4001	Figure
Approved by: GL	Date: 3/7/2018		B-2-4

12" HP12x53, Static Loading, Free Head









Lateral Load Applied at Pile Head

— 9 kips — 14 kips — 19 kips

Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011
Drawn by: YJ	Scale: N.T.S.
Checked by: GL	File Name:
Approved by: GL	Date: 3/7/2018

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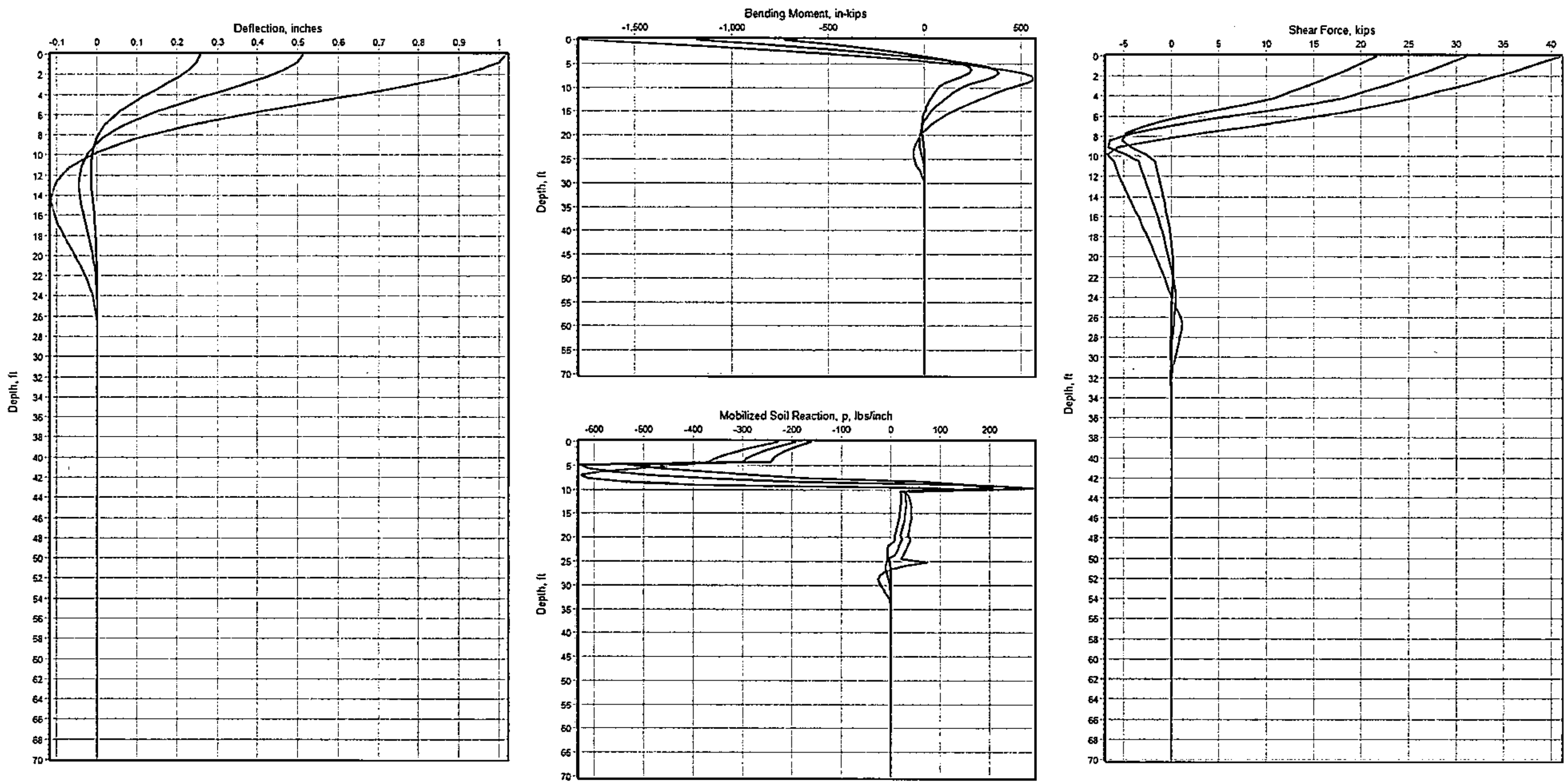
LPILE Analyses

Travis Field WWTF
Savannah, Georgia

Figure
B-2-5

12” HP12x53, Static Loading, Fixed Head



Lateral Load Applied at Pile Head

— 21 kips — 30 kips — 40 kips

Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011
Drawn by: YJ	Scale: N.T.S.
Checked by: GL	File Name:
Approved by: GL	Date: 3/7/2018

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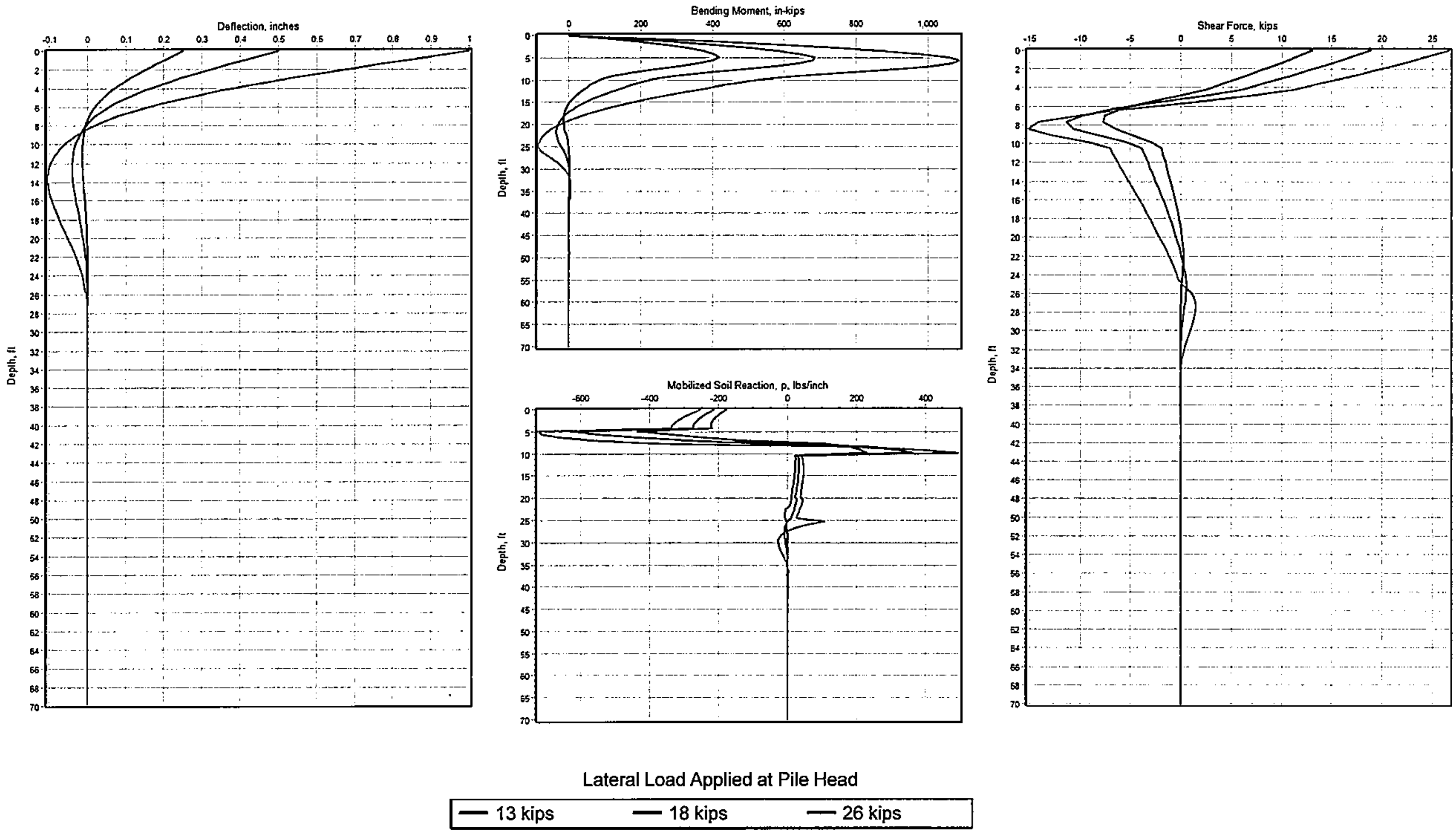
LPILE Analyses

Travis Field WWTF
Savannah, Georgia

Figure
B-2-6

14" HP14x73, Static Loading, Free Head



Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011
Drawn by: YJ	Scale: N.T.S.
Checked by: GL	File Name:
Approved by: GL	Date: 3/7/2018

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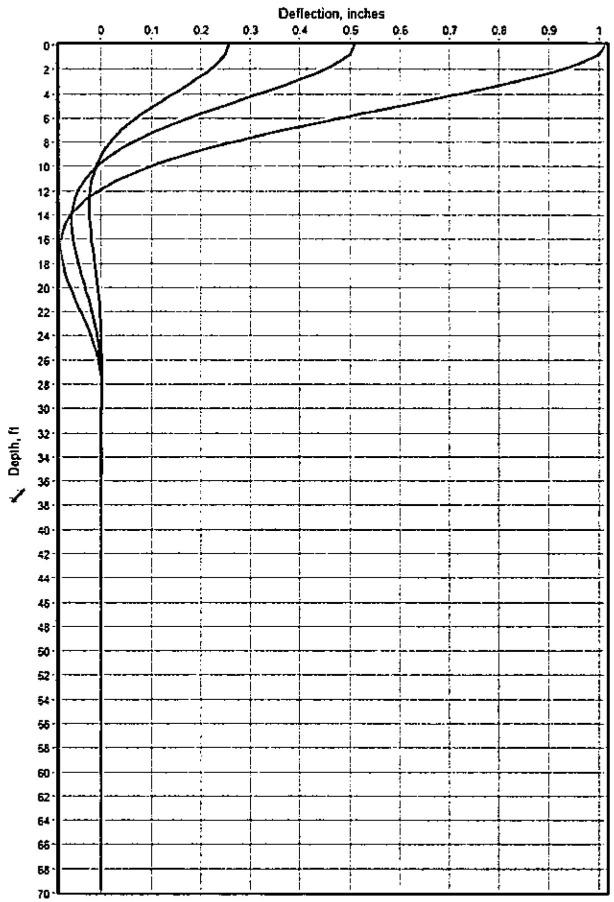
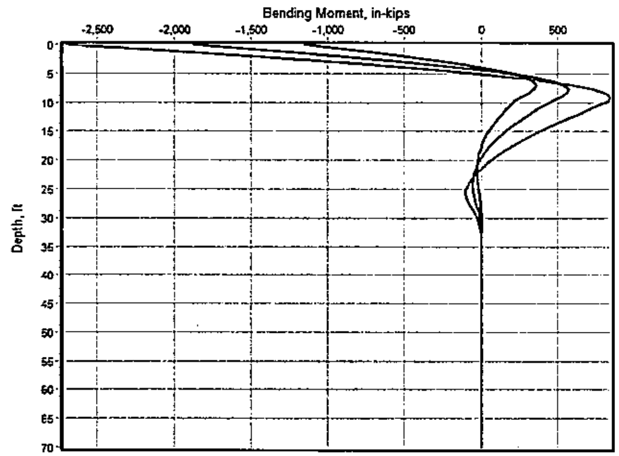
LPILE Analyses

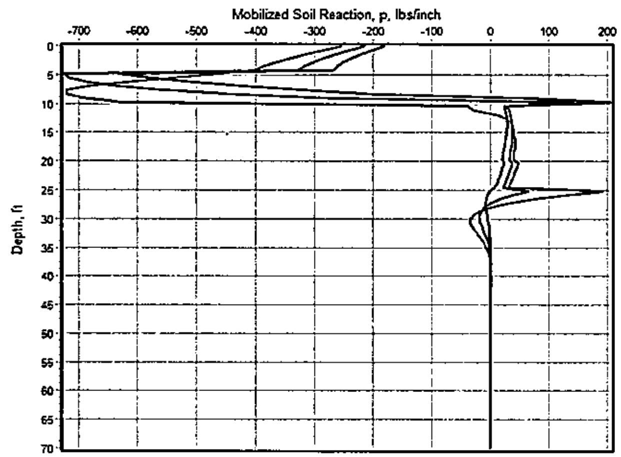
Travis Field WWTF
Savannah, Georgia

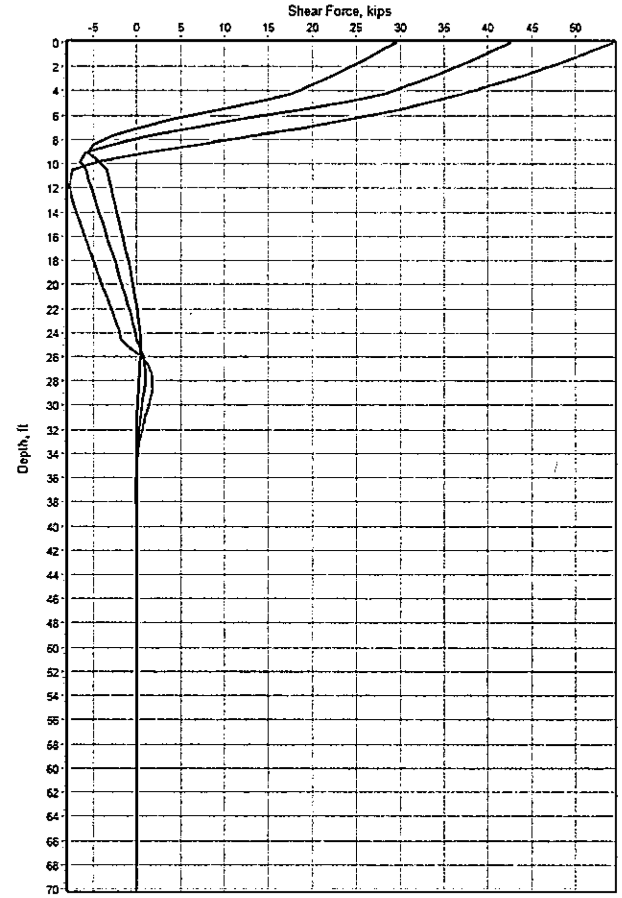
Figure
B-2-7

14" HP14x73, Static Loading, Fixed Head









Lateral Load Applied at Pile Head

— 29 kips — 42 kips — 52 kips

Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager:	YJ	Project No.	ES185011
Drawn by:	YJ	Scale:	N.T.S.
Checked by:	GL	File Name:	
Approved by:	GL	Date:	3/7/2018

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LPILE Analyses

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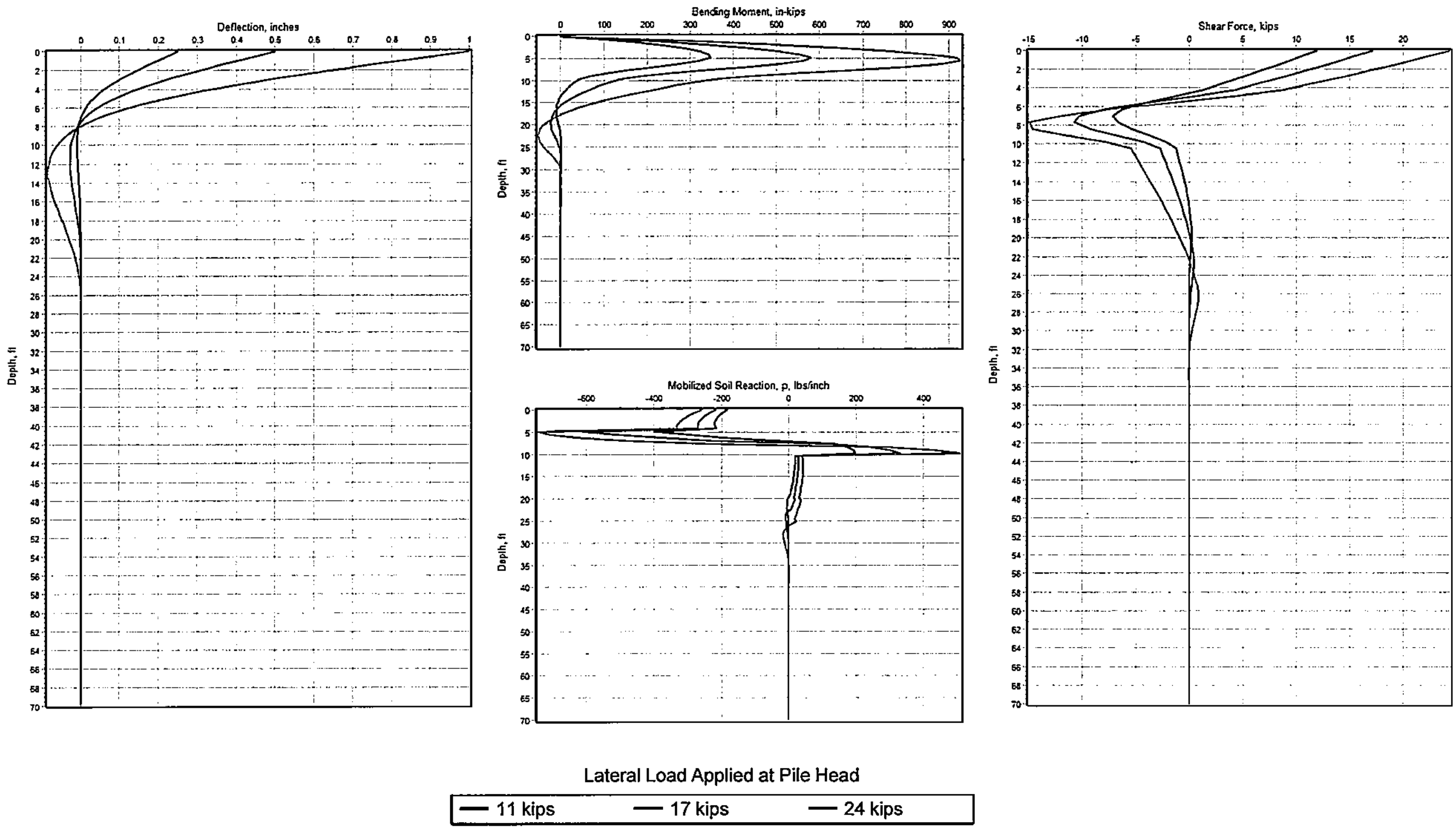
Figure
B-2-8

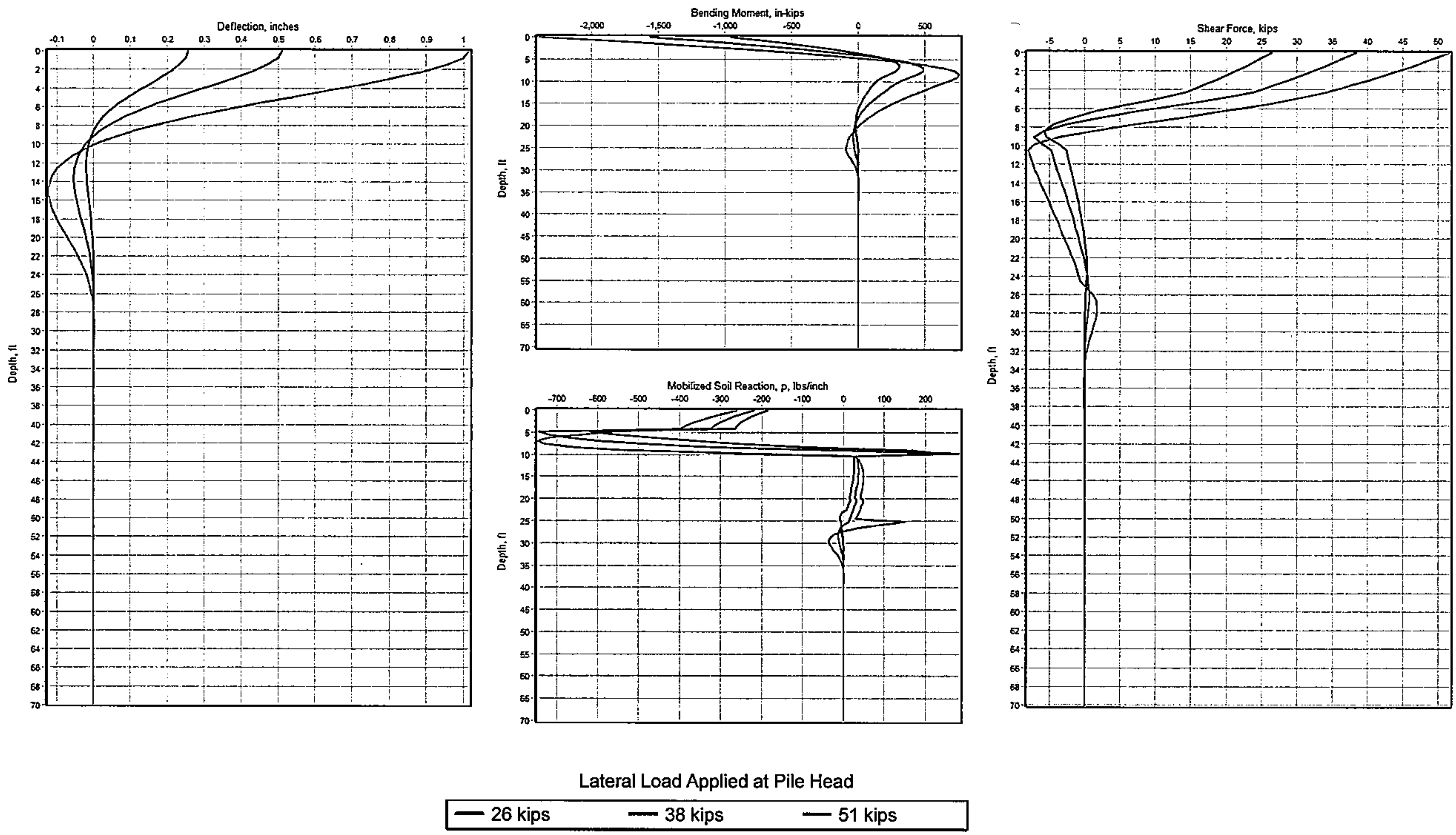
14” ACIP Piles, Static Loading, Free Head



Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011	Terracon Consulting Engineers & Scientists	LPILE Analyses
Drawn by: YJ	Scale: N.T.S.	2201 Rowland Avenue Savannah, Georgia 31404	Travis Field WWTF Savannah, Georgia
Checked by: GL	File Name:	Phone (912) 629 4000 Fax (912) 629 4001	
Approved by: GL	Date: 3/7/2018		Figure B-2-9

14" ACIP Piles, Static Loading, Fixed Head



Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011		
Drawn by: YJ	Scale: N.T.S.		
Checked by: GL	File Name:		
Approved by: GL	Date: 3/7/2018		

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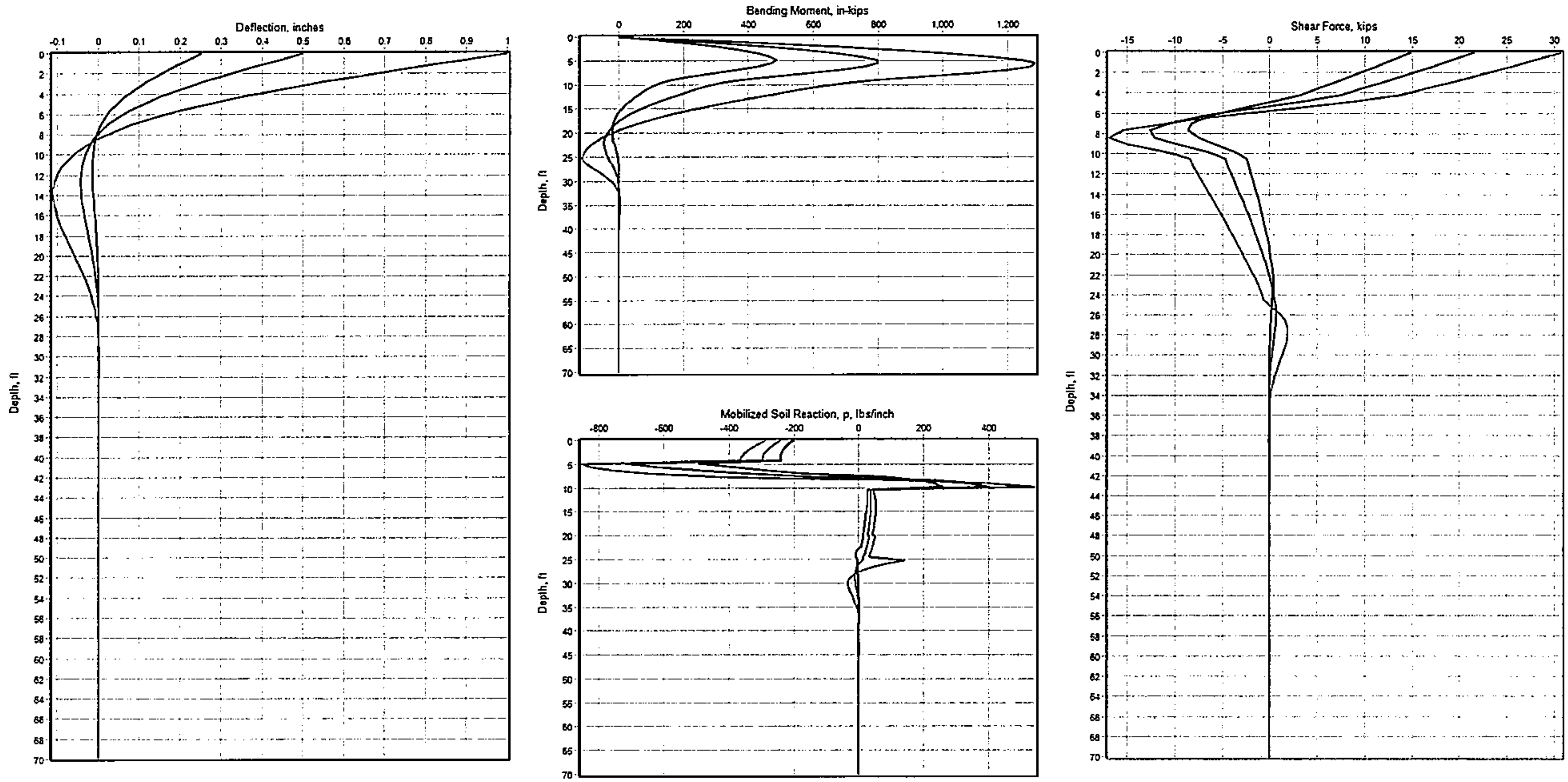
LPILE Analyses

Travis Field WWTF
Savannah, Georgia

Figure
B-2-10

16" ACIP Piles, Static Loading, Free Head



Lateral Load Applied at Pile Head

— 14 kips — 21 kips — 30 kips

Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager: YJ	Project No. ES185011		
Drawn by: YJ	Scale: N.T.S.		
Checked by: GL	File Name:		
Approved by: GL	Date: 3/7/2018		

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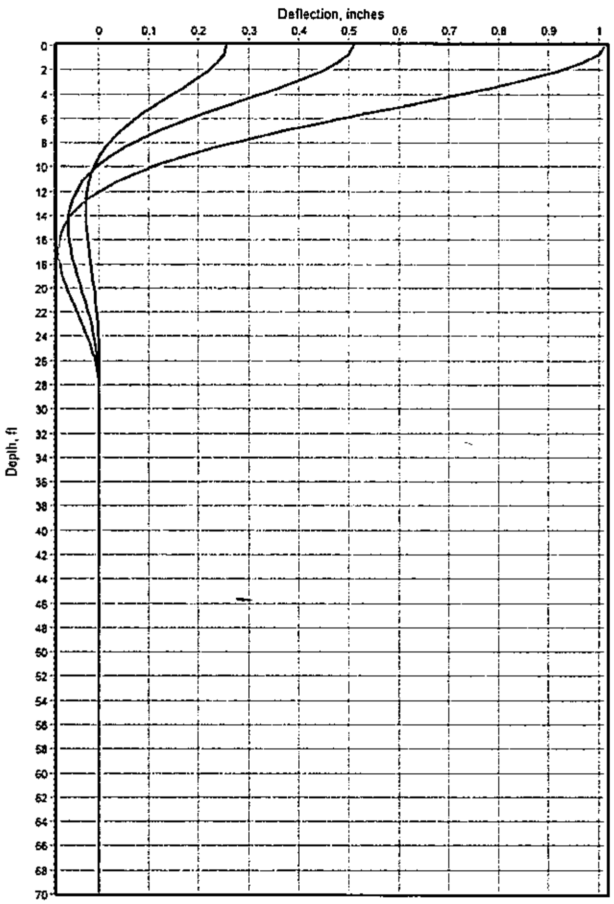
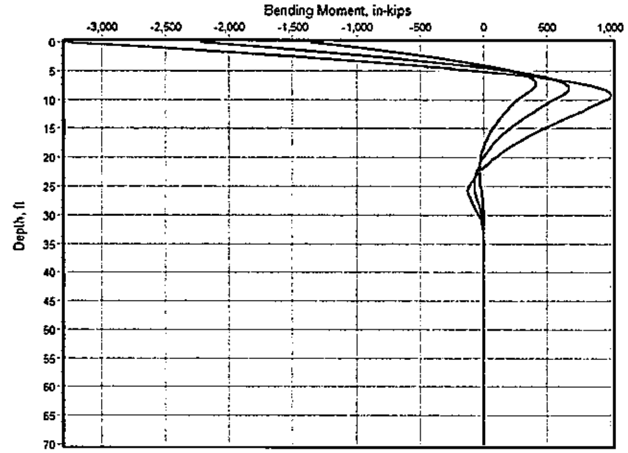
LPILE Analyses

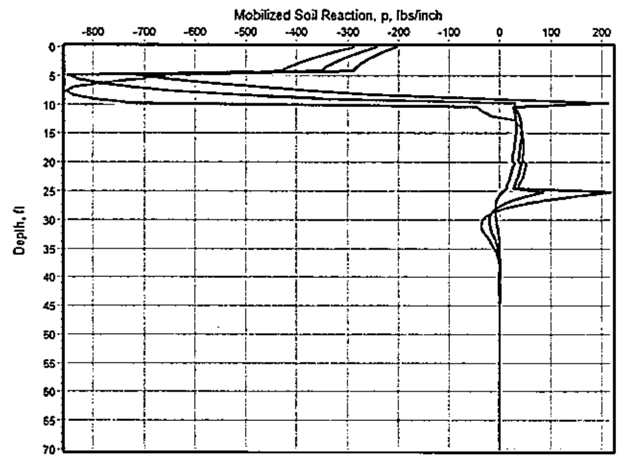
Travis Field WWTF
Savannah, Georgia

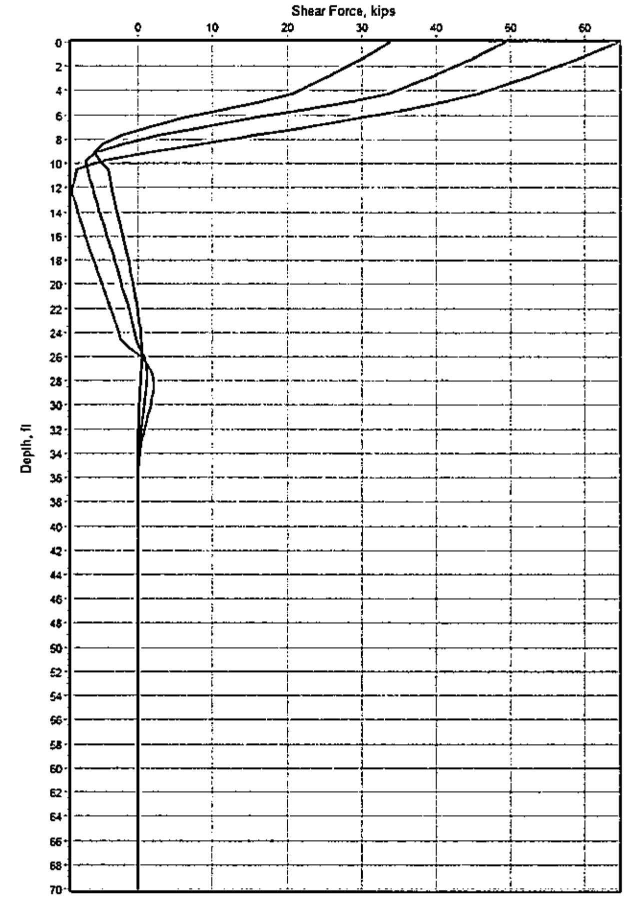
Figure
B-2-11

16" ACIP Piles, Static Loading, Fixed Head









Lateral Load Applied at Pile Head

— 33 kips — 48 kips — 63 kips

Note:
- Depth in vertical axis means the distance below pile head.
- Pile head is at the existing ground surface

Project Manager:	YJ	Project No.	ES185011
Drawn by:	YJ	Scale:	N.T.S.
Checked by:	GL	File Name:	
Approved by:	GL	Date:	3/7/2018

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LPILE Analyses

Travis Field WWTF
Savannah, Georgia

Figure
B-2-11

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Auger	Split Spoon
Shelby Tube	Macro Core
No Recovery	Rock Core
Ring Sampler	

GROUNDWATER

- Groundwater Initially Encountered
- Groundwater Level After a Specified Period of Time
- Static Groundwater Level After a Specified Period of Time
- No Groundwater Observed

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.		CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Std. Penetration Resistance (blows per foot)**	**Descriptive Term (Consistency)**	**Undrained Shear Strength (kips per square foot)**	**Std. Penetration Resistance (blows per foot)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium-Stiff	0.50 to 1.00	5 - 7
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 14
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	above 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Descriptive Term(s) of other constituents	Percent of Dry Weight
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

Exhibit B-3

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines Classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

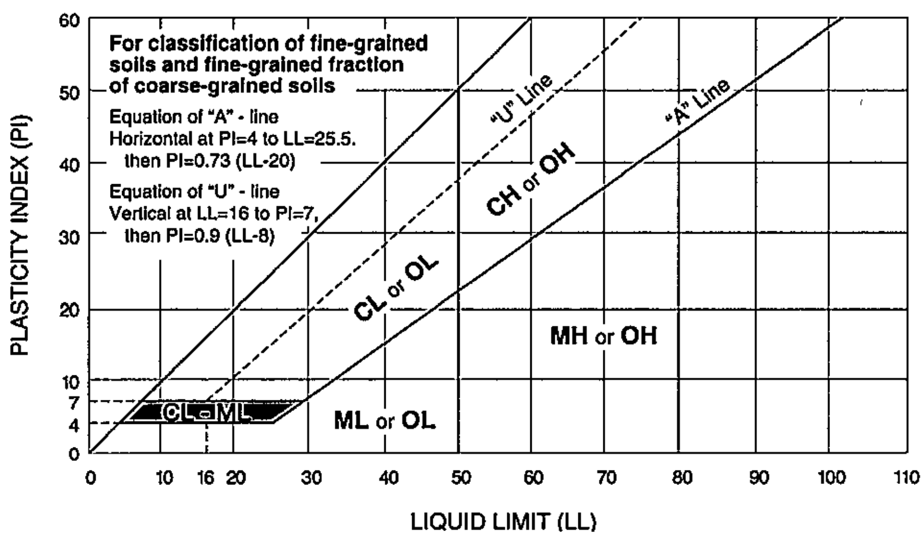
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



Terracon

Exhibit B-4

Form 111—6/98

For Earth, For Life
Kubota

April 23rd, 2019

Fred Sororian, PE
Thomas and Hutton
50 Park of Commerce Way
Savannah, GA 31405

Reference: Travis Field Water Reclamation Facility
Subject: Cost Allowance and BOM for MBR and MBT Digestion Systems Procurement. Project Specification Section 45 50 00 Membrane Bioreactor (MBR) System.

Dear Fred,

Per your request, Kubota Membrane USA is pleased to provide this detailed cost allowance for MBR and MBT equipment, spares, services, warranty, performance testing, shipping and all other requirements in accordance with Specification Section 45 50 00.

Please note that the RAS actuated flow control valves listed in Section 45 50 00 and indicated as two 24-inch and one 14-inch are not included in our BOM and are not being supplied by Kubota Membrane USA. All bidding contractors will need to include the cost of these three actuated valves separate from our BOM.

Kubota Membrane USA shall provide all equipment listed in the attached Bill of Materials (BOM) for a lump sum price of **$2,932,077**. Lump sum price does not include any local or federal sales tax or other fees.

Please do not hesitate to contact Jay Boudreuax or myself with any other questions or comments you may have.

Kind regards,

Damone Supica, PE
Product Engineer - MBR Systems | Kubota Membrane USA Corporation
Cell: 425-248-7897
Email: damone.supica@kubota.com Cc: Jay Boudreaux

4 Scope of Supply

Kubota Membrane USA is including the following equipment, instrumentation, controls, and services for the Travis Field WRF project. Kubota Membrane USA is including spare parts as described in Section 45 50 00 2.04.M.

4.1 Major Equipment and Instrumentation

Table 6: KMU Scope of Supply and Materials of Construction

Name	Type	Manufacturer	Model	Size / Motor HP	Power Requirements	Material of Construction	Quantity*
Anaerobic Basin (AN) Equipment							
Anaerobic Mixer	Submersible Mixer	Wilo	TR60-2.27-6/8	2.7 HP	460 VAC	Cast iron casing with Ceram C0 protective coating	2
Anaerobic Mixer Ancillary	Guide Rails, Guide Brackets, Lifting Cables, Thermal and Moisture Relays	Wilo	-	-	-	304SS	2 sets
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	3 (2 duty + 1 spare)
Pre-Anoxic Basin (Pre-AX) Equipment							
Pre-Anoxic Mixer	Submersible Mixer	Wilo	TR 75-2.17-6/16	6 HP	460 VAC	Cast iron casing with Ceram C0 protective coating	2
Pre-Anoxic Mixer Ancillary	Guide Rails, Guide Brackets, Lifting Cables, Thermal and Moisture Relays	Wilo	-	-	-	304SS	2 sets
RAS Pump	Submersible Pump	Flygt	NP 3202.095-614	60 HP	460 VAC	Cast iron casing and impeller	4 (3 duty + 1 spare)
RAS Pump Ancillary	Pump Mounting Stand and Inlet Elbow	Flygt	-	-	-	-	4 sets
Internal Recycle Flow Meter	Magnetic	Siemens	MAG 5100W	14-inch	115-230 VAC	ANSI B16.1 Class 150 carbon steel flanges	1
Feed Forward Flow Meter	Magnetic	Siemens	MAG 5100W	24-inch	115-230 VAC	ANSI B16.1 Class 150 carbon steel flanges	2

Name	Type	Manufacturer	Model	Size / Motor HP	Power Requirements	Material of Construction	Quantity*
Level Transmitter	Hydrostatic	Blue Ribbon, E+H, or equal	Bird Cage, FMX, or equal	-	10-30 VDC	316SS	2 (1 duty + 1 spare)
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	2
Pre-Aeration Basin (PA) Equipment							
Pre-Aeration Diffuser Assembly	Fine Bubble	EDI or Sanitaire	FlexAir Disc	1176 scfm	-	EPDM with PVC Manifold Assembly	2 sets
DO Meter	Sensor and Transmitter	Hach	LDO and SC100	-	100-230 VAC	304SS	2 sets
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	4
Feed Channel (FC) Equipment							
Feed Channel Mixer	Submersible Mixer	Wilo	TR50-2.33-6/8	2.7 HP	460 VAC	Cast iron casing with Ceram C0 protective coating	2
Feed Channel Mixer Ancillary	Guide Rails, Brackets, Lifting Cables, Thermal and Moisture Relays	Wilo	-	-	-	304SS	2 sets
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	2
Membrane Bioreactor Basin (MBR) Equipment							
Kubota Submerged Membrane Unit	Flat Plate	Kubota	SP600	-	-	Chlorinated Polyethylene Membrane 304 Stainless Steel Frame	36 units
SMU Ancillary	Plates, Poles, Brackets, etc., for SMU Guide and Stabilizer	Kubota	-	-	-	304 Stainless Steel	36 sets
Air Isolation Valve	Butterfly	Keystone or equal	GRL Lug Style or equal	3-inch	-	Cast Iron	36
Permeate Isolation Valve	Butterfly	Asahi or equal	Type 21 or equal	3-inch	-	PVC	72
Air Piping located inside of MBR basins	Air piping < 4" inside MBR basins	Kubota	-	< 4-inch	-	PVC piping at and below liquid level	36 sets
Permeate piping located inside of MBR basins	Permeate piping < 4" inside MBR basins	Kubota	-	< 4-inch	-	Sch. 80 PVC	36 sets
Degas Valve	Electric Actuated	ASCO or equal	EF Series or equal	3-inch	-	DI Body, EPDM Seat	8

Name	Type	Manufacturer	Model	Size / Motor HP	Power Requirements	Material of Construction	Quantity*
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	8
MBR Permeate System Equipment							
Pressure Transmitter	Diaphragm	Siemens	SITRANS P DS III	-	24 VDC	-	5 (4 duty + 1 spare)
Permeate Flow Meter	Magnetic	Siemens	MAG 5100W	12-inch	115-230 VAC	ANSI B16.1 Class 150 carbon steel flanges	4
Permeate Pump	Self-Priming Centrifugal	Gorman-Rupp	T10A60S-B	15 HP	460 VAC	Gray Iron Casing, Ductile Iron Impeller, Gray Iron Housing	4
Permeate Flow Control Valve	Actuated Modulating Butterfly Valve	Limitorque Actuator	SQR05.2/AC01.2	12-inch	120 VAC	DI Body, EPDM Seat	5 (4 duty + 1 spare)
Pressure Gauge	Gauge with Diaphragm Seal	Ashcroft	Duragauge	-	-	316 Stainless Steel Wetted Material	8
Turbidity Analyzer	Probe and Transmitter	Hach	1720E and SC100	-	100-230 VAC	-	4 (with 1 spare probe)
MBR Aeration System Equipment							
MBR Air Flow Meter	Thermal Mass	E+H	Model 65i	8-inch	85-260 VAC	-	4
Pressure Transmitter	Diaphragm	Siemens	SITRANS P DS III	-	24 VDC	-	5 (4 duty + 1 spare)
MBR Air Scour Blower Package	Positive Displacement	Aerzen	GM 35S	75 HP	460 VAC	AISI 1045 Rotor Shaft with CI Blower Housing	4
Aeration Zone Blower Package	Positive Displacement	Aerzen	GM 60S	100 HP	460 VAC	AISI 1045 Rotor Shaft with CI Blower Housing	3 (2 duty + 1 common standby)
MBR/MBT Cleaning System Equipment							
Water Supply Valve	Actuated On/Off Plug Valve	Limitorque Actuator	SQR12.2/MC01.1	4-inch	120 VAC	CI Body	1
Pressure Gauge	Gauge	Ashcroft	Duragauge	-	-	316 Stainless Steel Wetted Material	4

Name	Type	Manufacturer	Model	Size / Motor HP	Power Requirements	Material of Construction	Quantity*
Chemical Flow Indicator	Rotameter	Blue White	-	-	-	Polysulfone	2
MBR Solution Flow Meter	Magnetic	Siemens	MAG5100W	4-inch	115 VAC	-	1
MBT Solution Flow Meter	Magnetic	Siemens	MAG5100W	2-inch	115 VAC	-	1
MBR Chemical Injector	Venturi	Mazzei	-	4-inch	-	PVDF	1
MBT Chemical Injector	Venturi	Mazzei	-	2-inch	-	PVDF	1
Isolation Ball Valve	Ball valve	Asahi	-	2-inch	-	PVC	4
Isolation Ball Valve	Ball valve	Asahi	-	4-inch	-	PVC	4
Digester 1 (DIG1) Equipment							
Digester 1 Diffuser Assembly	Coarse Bubble	EDI or Sanitaire	MaxAir	1241 scfm	-	CPVC	1 set
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	1
Sludge Transfer Pump	Airlift	PB Equipment	-	125 gpm	-	Stainless Steel	1
Digester 2 (DIG21) Equipment							
Digester 2 Diffuser Assembly	Coarse Bubble	EDI or Sanitaire	MaxAir	320 scfm	-	CPVC	1 set
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	1
Level Transmitter	Hydrostatic	Blue Ribbon, E+H, or equal	Bird Cage, FMX, or equal	-	10-30 VDC	316SS	1
Membrane Thickener Basin (MBT) Equipment							
Kubota Submerged Membrane Unit	Flat Plate	Kubota	RM200	-	-	Chlorinated Polyethylene Membrane 304 Stainless Steel Frame	3 units

Name	Type	Manufacturer	Model	Size/ Motor HP	Power Requirements	Material of Construction	Quantity*
SMU Ancillary	Plates, Poles, Brackets, etc., for SMU Guide and Stabilizer	Kubota	-	-	-	304 Stainless Steel	3 sets
Air Isolation Valve	Butterfly	Keystone or equal	GRL Lug Style or equal	3-inch	-	Cast Iron	6
Permeate Isolation Valve	Butterfly	Asahi or equal	Type 21 or equal	3-inch	-	PVC	3
Diffuser Cleaning Valve	Actuated On/Off Plug Valve	Limitorque Actuator	SQR12.2	6-inch	120 VAC	DI Body	1
Air Piping located inside of MBT basins	Air piping < 4" inside MBR basins	Kubota	-	< 4-inch	-	PVC piping at and below liquid level	3 sets
Permeate piping located inside of MBT basins	Permeate piping < 4" inside MBT basins	Kubota	-	< 4-inch	-	Sch. 80 PVC	3 sets
Level Switch	Float	Conery or Kobold	2902 Series or NAE Series	-	120 VAC	ABS or Polypropylene	2
Degas Valve	Electric Actuated	ASCO or equal	EF Series or equal	3-inch	-	DI Body, EPDM Seat	1
MBT Permeate System Equipment							
Pressure Transmitter	Diaphragm	Siemens	SITRANS P DS III	-	24 VDC	-	1
Permeate Flow Meter	Magnetic	Siemens	MAG 5100W	1-inch	115-230 VAC	ANSI B16.1 Class 150 carbon steel flanges	1
Permeate Pump	Progressive Cavity	Netzsch	NEMO	2 HP	460 VAC	Cast Iron Housing, Plated Steel Rotor	2 (1 duty + 1 standby)
Pressure Gauge	Gauge with Diaphragm Seal	Ashcroft	Duragauge	-	-	316 Stainless Steel Wetted Material	4
Pressure Switch	Diaphragm	UE	Series 25	-	24 VDC	EPDM Sensor	2
MBT Aeration System Equipment							
MBT Air Scour Blower Package	Positive Displacement	Aerzen	GM 10S	20 HP	460 VAC	AISI 1045 Rotor Shaft with CI Blower Housing	1
Digester 1 Blower Package	Positive Displacement	Aerzen	GM 35S	75 HP	460 VAC	AISI 1045 Rotor Shaft with CI Blower Housing	2 (1 duty + 1 common standby)
Digester 2 Blower Package	Positive Displacement	Aerzen	GM 25S	30 HP	460 VAC	AISI 1045 Rotor Shaft with CI Blower Housing	1

WAS Pump Equipment							
WAS Flow Meter	Magnetic	Siemens	MAG 5100W	4-inch	115-230 VAC	ANSI B16.1 Class 150 carbon steel flanges	1
WAS Pumps	Self-Priming Centrifugal	Gorman-Rupp	T4A	5 HP	460 VAC	Gray Iron Casing, Ductile Iron Impeller, Gray Iron Housing	2
WAS/Drain Flow Control Valve	Actuated Open/Close Plug Valve	Limitorque Actuator	SQR05.2/AC01.2	4-inch	120 VAC	DI Body, EPDM Seat	2
Pressure Gauge	Gauge with Seal	Ashcroft	Duragauge	-	-	316 Stainless Steel Wetted Material	4
MBR/MBT Control Panel							
MBR and MBT Control System	MBR SCADA, PLC, HMI	Kubota / MR Systems	-	-	-	-	1

*-all units are duty except where noted otherwise.

A GRUNDFOS COMPANY
ENAQUA
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1350 Specialty Drive, Ste F
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Fax: (+1)7605992642
www.enaqua.com

FRED SORORIAN, PE | Project Engineer
Thomas & Hutton
50 Park of Commerce Way
Savannah, GA 31405

Name: Arijit Sarkar
Direct : 760 599 2644 # 1102
Email: asarkar@grundfos.com
Date: 03/28/2019

REF: Travis Field Water Reclamation Facility
SUB: Cost Allowance and BOM for UV Disinfection System Procurement. Project Specifications SECTION 44 44 73 ULTRAVIOLET DISINFECTION SYSTEM (NON-CONTACT)

Dear Fred,

Per your request Enaqua is pleased to provide this detailed cost allowance for equipment, spares, services, warranty, shipping, and all other services in accordance with the above referenced project specifications, and the relevant specifications referenced in SECTION 44 44 73 ULTRAVIOLET DISINFECTION SYSTEM (NON-CONTACT).

Enaqua shall furnish the UV Disinfection System Equipment, associated equipment items and services per project specifications for the lump sum of **US $559,170.00** for Phase I as detailed in Table 1.0 below. The lump sum quote for Phase I shall be valid for six (6) months from the date of this letter.

A requested schedule of payment is provided in Table 1.2 below. Detailed scope of supply for UV reactors, instruments, sensors, UV Control Panel, UV Power Panels, UV Pump Control Panels, Spares, Start-up training and maintenance services, performance warranty, and equipment warranty- in accordance with contract specifications SECTION 44 44 73 ULTRAVIOLET DISINFECTION SYSTEM (NON-CONTACT) are provided in Tables 1.2 – 1.10.

Please do not hesitate to contact me with any questions you may have regarding the information in this document, or the Enaqua Non-Contact UV Disinfection system operation. Thank you for the opportunity to provide you with this cost allowance and bill of materials and pricing for Phase I of this project.

Regards,

Arijit Sarkar

Arijit Sarkar
Applications Manager

Table 1.0 – Guaranteed Lump Sum Quote for Phase I

	Cost ($)
UV Disinfection System, as specified in the Technical Specifications (sales taxes should be included)	$508,000.00
Spare parts and special tools, as specified in the Technical Specifications	$6,120.00
Freight, as specified in the Technical Specifications	$15,300.00
Supervision of installation, testing, training, commissioning, warranty, and Follow-up support services. (Per Technical Specifications)	$29,750.00
Total Equipment Cost (Sum of Items #1 - 4) (Including State Sales taxes)	**$559,170.00**

Table 1.1: Requested Payment Schedule

Milestone	% Payment
Percentage of the bid item to be paid upon Engineer's approval of equipment submittals	30.0
Percentage of the bid item to be paid upon delivery of the equipment and the Preliminary O&M Manuals to the project site in a condition acceptable to the Contractor, Owner, and Engineer	30.0
Percentage of the bid item to be paid on successful operation and field testing of the equipment and delivery of the Final O&M Manuals	30.0
Retainage after final acceptance of project	10.0*

*Note: Assumed retainage of 10.0%. To be revised based on the requirements for retainage for UVSS as specified for this project.

Table 1.2 – Detailed Scope of Supply for Phase I- UV Reactors

UV REACTOR MODEL	**C8t.10082**
Reactor Type	In-Pipe Flanged
Process Connection	24" Flange (ASME/ANSI B16.5, CL 150)
ENLIGHT XUV60 UV LAMP- Enaqua Part number: 001.0617SLM	145-Watt Low Pressure High Intensity- Non-Amalgam Smart Lamps
Ballasts-Enaqua Part number: 502.5V2427M	145 Watt- Enlight high efficiency electronic ballast
Non-contact Reactor Material	C Series AFP840™ Tube
Material of Construction	316 Stainless Steel for all wetted parts
UV REACTOR(s)	
Number of Proposed UV Reactor(s)	2
Number of Banks per Reactor	2
Number of AFP tubes per bank	80 (In two bank length)
Number of Lamp Racks per Bank	9
Number of Lamps per Rack	12
Number of Lamps per Bank	108
Number of Lamps per Reactor	216
Number of Ballasts per Reactor	216
Total Number of UV Lamps (System)	432
REACTOR-THERMAL MANAGEMENT SYSTEM	
Air-Liquid Heat Exchangers installed inside reactor body.	Four per UV Bank
Cooling Pumps	2 per UV reactor (1 duty 1 standby)

UV INTENSITY SENSORS	
UV intensity Monitors- Enaqua part number: 560.601902	4 (One per UV Bank)
EFFLUENT LEVEL CONTTOL MECHANISM	
Rectangular contracted weir plate and weir frame installed in effluent tank of UV reactors. Weir plate, frame, mounting accessories 316L SS.	2 One per UV Reactor)

Table 1.3– Detailed Scope of Supply for Phase I- Third Party Sensors and Instruments

INSTRUMENTS	
EchoSpan Ultrasonic Level Transmitter, model LU81	2 (1 per UV reactor)
Bypass UV Transmittance Sensor, Transmitter, and CIP. REALTECH REAL UV Model M3000, and REAL PUMP CLEAN SYSTEM 1	1

Table 1.4– Detailed Scope of Supply for Phase I- UV Control Panel Components

ENAQUA UV Control Panel Components (FCP UV)			
ENAQUA MICROCONTROLLER BASED COMPONENTS			
Item	**Part Number**		**QTY**
EDC GEN 2 (Ensure Dosing Controller)	062.01003700		2
PIO (Discrete IO Module)	062.01003600		4
AIO GEN 2 (Analog IO Module)	062.01003800		1
Data HUB GEN 2- Enaqua part number:	602.01003900		1
THIRD PARTY COMPONENTS			
Item	**Manufacturer**	**Part Number**	**QTY**
UV Control Panel Enclosure-316L SS NEMA 4X	Rittal	WM483612N6	1
19-inch color touchscreen display (HMI)	Hope Industrial	HIS-ML19 (Rev. G)	1
Windows 10 PC	AMOS	3005-1Q12A2	1
Circuit Breakers	Weidmuller	BR1C10AC	2
		BR1C20AC	1
24VDC Power Supply	IDEC	PS5R-SD24	2
Ethernet Switch, 8 port 10/100BaseT(X) (RJ45 connector	Weidmuller	IE-SW-BL08-8TX	1
120V Receptacle	Weidmuller	6720005421	2

Pump Control Relays	Schneider	RPM22F7	6
UPS	Allen-Bradley	1609-B1000N	1
HMI ON/OFF Switch	IDEC	CW1S-2E10	1
HOA Switches	IDEC	CW1S-2E20	9

Table 1.5– Detailed Scope of Supply for Phase I- UV Bank Power Disconnect Panels

UV BANK POWER DISCONNECTS	
Panel Enclosure – Rittal Model # WM161208N46	2(One per UV Reactor)
Main Power Disconnect – ABB Model # OT63F3	4 (One per Panel)
Power Distribution/ Terminal Block – Marathon Catalog # 1321580	As needed
Circuit Breaker – Weidmuller Part # BR1C20AC & BR3C30AC	8 (Four per Panel)
TVSS – Weidmuller Part # 6720005410 & 6720005412	8 (Four per Panel)

Table 1.6– Detailed Scope of Supply for Phase I- UV Pump Control Panels

UV PUMP CONTROL PANELS	
Panel Enclosure – Rittal Model # WM201608N6	2 (One per Reactor)
Circuit Breaker – Weidmuller Part # BR1C40AC & BR3C10AC	4 (Two per Panel)
Power Distribution/ Terminal Block – Marathon Catalog # 1321580	As Needed
Pump Motor Protector – ABB Model # MS116-12	4 (Two per Panel)
Pump Contactor – ABB Model # AF65-30-11-13	4(Two per Panel)

Table 1.7 –Detailed Scope of Supply for Phase I- Spares

ITEM	QTY
Spare Lamps (10.0% additional)	44
Spare Ballasts (5.0% additional)	22
Quartz Sleeves	N/A
Lamp Sealing Rings or Holder Seals	N/A
Lamp Plugs/ Lamp End Connectors (5.0% additional)	22
Wiper or Wiper Rings	N/A
Proprietary Printed circuit boards (EDC, PIO, LRC Board, MLM, ADR, HUB)	1 of each listed
Proprietary Printed circuit boards {MLM) (5.0% additional)	2
Pump or Electric Motor. Cooling Pumps for UV Reactors	1
UV Intensity Sensor- Enaqua part number: 560.601902	1
Operator's safety kit includes UV resistant Gloves, and Face Shields that block UV light wavelengths between 200 and 400 nm.	2
AFP Tube Cleaning Kit- Teflon Brush and extension kit with adaptable poles.	2

N/A: Not applicable for Non-Contact UV system

Table 1.8: Detailed Scope of Supply- Installation, On-Site Services, Testing, Start-UP, Training and Maintenance trips

Trip #	Trip Description	Hours/day	# Days	# of Trips
1	**Installation Supervision and Inspection**: Minimum 7 person-days to handle various requests by the City, including during the unloading of UV disinfection equipment system (assume one trip) and for providing installation assistance for the UV Disinfection Equipment System (assume one trip).	8	7	1
2	**Start-Up and Field-Testing:** Minimum 10 person-days to handle various requests by the City, for assistance during startup activities (assume two trips).	8	10	2
3	**Operator Training:** Training shall consist of a minimum of total of 16 hours, for multiple classes, of hands-on lectures on the UV Disinfection Equipment System operation and the maintenance requirements, including lamp chemical cleaning and replacement and repair processes for lamps, ballasts, wipers, sleeves and ancillary equipment. Training shall take place before the Initial Performance Test. The field training shall cover all shifts.	8	2	-
4	**Additional Site Visit**- SUPPLIER shall return for 2 additional days 1 year after final acceptance to review UV Disinfection System performance, operations, and maintenance.	8	2	1
5	**Maintenance Service** - Service Scheduling: a. By City request any time during warranty period as specified on the Warranty Form.	-	-	-

Table 1.9: Detailed Scope of Supply- PERFORMANCE WARRANTY

1.05.A.1 - PERFORMANCE WARRANTY	a. Manufacturer shall guarantee the specified performance (system shall meet minimum UV doses specified in Section 1.3.C under the conditions specified in the design criteria section) for a period of five (5) calendar years following equipment startup and acceptance to allow evaluation of performance under the specified water quality conditions. The system must be maintained and operated per the manufacturer's recommendations and instructions. b. If the UV disinfection system fails to meet the performance guarantee criteria or fail to demonstrate performance, the manufacturer shall modify, change, or add equipment as necessary to meet performance requirements. The manufacturer shall be responsible for any additional costs due to changes (including piping, mechanical, structural or electrical changes) or additional equipment as necessary to meet performance requirements. This includes design, engineering, construction, as well as equipment.

Table 1.10: Detailed Scope of Supply- EQUIPMENT WARRANTY

1.05.B.1 - GENERAL WARRANTY	**a.** The equipment furnished under this section shall be free of defects in materials and workmanship, including damages that may be incurred during shipping, storage, and installation, for a period of **2 years** which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system).

	b. All wiring in the train exposed to UV light shall be warranted for 15 years by the SUPPLIER. If the wiring fails before **15 years** have elapsed, the SUPPLIER shall be responsible for the replacement of the wires and the labor. **c.** Enaqua shall guarantee that for components manufactured by Enaqua, replacement parts shall continue to be available to the City for a minimum of **20 years** from date of successful completion of Initial Performance Test. Enaqua shall guarantee that, if Enaqua or Enaqua's product line is sold, Enaqua shall make provisions such that all guarantees, warrantees, and bonds will remain in effect and that replacement parts and operational support shall continue to be available to the City for the time period specified above. **d.** **No warrantees shall be pro-rated**, and all warrantees shall include all costs associated with required site visits, inspections, equipment removal costs, and equipment installation costs. **e.** All warrantees and support shall be provided directly by the SUPPLIER and not the local manufacturer's representative.
1.05.B.2- UV LAMP WARRANTY	**a.** UV lamps shall be warranted for a minimum of 16,000 hours operating time under the conditions specified herein non- prorated. In the event of premature UV lamp failure, the UV system supplier shall offer the following: 1. Lamp failure before 16,000 hours – send a replacement lamp free of charge. **b.** This guarantee shall be limited by the guaranteed number of start/stop cycles. The guaranteed lamp start/stop cycle shall be **24** stop/start cycles per 24-hour period over the life of the lamp. The automation associated with the UV equipment shall be programmed to prevent more than 24 start/stop cycles per day. Additionally, the automation system must log the operational hours for each individual lamp. **c.** The guaranteed lamp life shall not include periods when the plant is not in operation and/or when the UV system is shut down. **d.** SUPPLIER shall ensure all returned UV lamps (old/new) are recycled upon receipt of the returned lamps at the manufacturing headquarters for the life of the UV Disinfection System (20 years after successful completion of the Initial Performance Test).
1.05.B.3 - UV BALLAST WARRANTY	**a.** SUPPLIER shall guarantee all ballasts against failure for a minimum period of 10 years, which shall commence after successful completion of the Initial Performance Test (Substantial Completion of the UV system). **b.** SUPPLIER shall replace any ballast that fails before the end of the designated warranty period at no cost to the City, with freight and insurance paid by SUPPLIER. Installation of the failed ballast can be performed by City.
1.05.B.4- AFP TUBE WARRANTY	AFP tubes shall be warranted for twenty years as long as the wastewater flow and quality remains in the range(s) specified in the Design Criteria, and the UV system is operated in accordance with the O&M manual

1.05.B.5- UV SENSOR WARRANTY	UV sensors shall be guaranteed against failure for a minimum of five (5) years.

END OF COST ALLOWANCE AND BOM -Dated 03/28/2019

PRINCIPLE
ENVIRONMENTAL, inc.
1770 The Exchange • Suite 210 • Atlanta, GA 30339

April 5, 2019

TO: ALL BIDDING CONTRACTORS
SUBJECT: City of Savannah
Travis Field WRF
REFERENCE: Grit Removal Equipment

The proposals from Hydro International for one Headcell grit separator and control panel and from Weir/Wemco for one 4" Model C grit pump and one 12" full flare Hydrogritter grit classifier follow.

The price negotiated with the City of Savannah and Thomas & Hutton for the combined system is **$376,000**.

Please let me know if you need any additional information.

Very Truly Yours,

Bob Sender
Principle Environmental, Inc.
1770 The Exchange
Suite 210
Atlanta, GA 30339
Office: 770-952-9444
Fax: 770-952-7933
Mobile: 404-644-6904 (best)
e-mail: bobsender@principleenvironmental.com
Please Visit Our Website at www.PrincipleEnvironmental.com

Water & Wastewater Solutions

Hydro International®

April 2, 2019

To: Mr. Fred Sororian
Thomas & Hutton
50 Park & Commerce Way
Savannah, GA WWTP

RE: Grit Removal System- Spec Section 46 23 66
Travis Field WWTP
Savannah, GA
File #17_11_0316

Hydro International is pleased to present our quote for a HeadCell® Grit Removal Unit. The unit will meet the requirements described in Section 46 23 66 with comments noted below.

Comments

1.
2. All piping connected to Hydro equipment must be supported by other means than the Hydro equipment.
3. Please see the exclusions detailed in the proposal below.

Equipment Summary

1. One (1) 12' 11 tray HeadCell® Grit Concentrator unit shall be supplied. The HeadCell® shall consist of a stack of nested trays. The trays shall be fabricated from UV stabilized polyethylene and shall be supported by a 304 SS frame integral to the unit. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials. The HeadCell® trays shall be constructed with a minimum ¼ inch material pans and sidewalls. The Tray Supports shall be fabricated to provide a means to independently support each tray and transfer the weight of each tray to the support structure frame. The HeadCell® will securely fit into a support structure frame containing the screened raw wastewater inlet connection, necessary hardware, and connections. The HeadCell® Concentrator shall be equipped with a settled solids underflow connection for collection and removal of settled solids. The settled solids are pumped to the Grit Washing unit from the HeadCell® unit.

   The unit shall remove 95% of all grit (S.G. 2.65) 106 micron and larger at a peak flow of 20 mgd. The unit shall have 12 inches of headloss at the peak flow.

2. One (1) control panel shall be supplied. The control panel shall have a NEMA 4X 316 stainless steel enclosure, and shall be rated at three phase, 480 VAC. The panel shall be programmable relay based and contain all relays, timers, switches, variable frequency drives and indicator lights to operate one (1) Hydrogritter unit and one (1) grit pump in either fully automated or manual mode.

Appurtenances Per Unit

HeadCell® Grit Concentrator

DESCRIPTION	QTY
Fluidizing Water Throttling Globe Valve 1" Crane Globe Valve, Bronze	1
Fluidizing Water Shut-off Valve 1" Apollo Ball Valve, Bronze	1
Fluidizing Water Flow Meter 1" 8-40 Blue & White Flow Meter, Stainless Steel	1

Utility Requirements

Clarified NPW or Reuse Water:

The HeadCell® unit requires continuous 20 gpm @ 50 +/- 10 psig of clarified water for "fluidizing" to function properly.

Spare Parts

No spare parts are included or recommend in this scope of supply.

Start-up

One (1) factory trained representative, two (2) trips, for start-up and instruction services as required totaling four (4) days.

Exclusions

Any item(s) not specifically described above are excluded and are not to be supplied by Hydro International including but not limited to the following:

- Field assembly, erection and installation
- Anchor Bolts
- Interconnecting piping and valving not expressly stated above
  Pipe connections and fittings not expressly stated above
- All pipe supports, hangers and braces
- Controls, switches, control panels and instrumentation of any kind not expressly stated above
- Wiring and conduit
- Grit pump(s) and associated piping, valving, gauges
- Covers and access hatches
- Field or touch-up paint, painting, blasting and touch-up of surface finish
- Spare parts not specifically stated above
- Unloading, hauling and storage charge
- Lubricating oil and greases
- Grit study, field performance testing, laboratory testing and sample collection and analysis
- All concrete and grouting work
- Insulation and heat tracing of any kind
- Structural / Seismic analysis
- Performance, Warranty, Efficacy and/or Supply Bond(s)
- Grit dumpsters
- Translation Services
- Washing / Dewatering equipment

Limitations

- General Liability is limited to $5,000,000 per each occurrence
- Products Completed & Operations Liability is limited to $5,000,000 per each occurrence
- Worker's Compensation is limited to $5,000,000 per each accident

Warranty

Hydro International's 12-month warranty from beneficial occupancy shall apply per the Terms and Conditions of Sale.

Delivery

Please allow 4 to 6 weeks after receipt of purchase order for approval drawings. Shipment is typically a maximum of 12-16 weeks after receipt of "Approved" or "Approved As Noted, Resubmittal Not Required" submittal package. Price includes truck freight to jobsite but does not include any state or local taxes if required. The grit removal system shall be delivered to site fully fabricated, subject to size, packaging and transportation constraints. The General Contractor must inspect equipment prior to unloading and notify Hydro International of any damage to equipment within 5 days to effect proper remedial action. Failure to notify Hydro International of damage to equipment prior to unloading will void all warranties pertaining to subject equipment.

Terms & Conditions

Hydro International payment terms are detailed in the attached terms and conditions. The pricing submitted herein is based on specification sections 46 23 66 and 46 23 67 and drawing set 26963 delivered to Hydro on January 14, 2019. Any changes to the scope of supply required by changes to these specification sections or other sections and drawings not provided to Hydro International as listed above may require the price to change. Hydro International reserves the right to amend the price if changes are required due to changes to the provided specifications or to meet requirements for sections not made available at the time of this quote. Price includes truck freight to jobsite and does not include any state or local taxes if required. The prices quoted are firm based on a receipt of a purchase order by October 29, 2019 and shipment of the equipment prior to April 28, 2020.

Purchase Order

Please make purchase orders to:

Hydro International

2925 NE Aloclek Drive, Suite 140

Hillsboro, OR 97124

Local Representative

Plant Representative:

Mr. Bob Sender

Principle Environmental, Inc.

1770 The Exchange, SE, Suite 210

Atlanta, GA 30339

Ph: (404) 644-6904

Fax: (770) 952-7933

bobsender@principleenvironmental.com

If you have any questions or concerns, do not hesitate to contact me.

Regards,

Hydro International

Sam Randall

Sam Randall
Applications Engineer

Standard Terms and Conditions of Sale

1. **DEFINITIONS.** "Hydro" is Hydro International with an address of 2925 NE Aloclek Drive #140 in Hillsboro, Oregon. "Buyer" is the party purchasing the goods from Hydro.

2. **ENTIRE AGREEMENT**. Hydro's agreement is based on these terms and conditions of sale. This document, together with any additional writings signed by Hydro, represents a final, complete, and exclusive statement of the agreement between the parties and may not be modified, supplemented, explained, or waived by parol evidence, Buyer's purchase order, any course of dealing, Buyer's payment or acceptance, or in any other way except in writing signed by Hydro through its authorized representative. These terms and conditions are intended to cover all activity of Hydro and Buyer hereunder, including sales and use of products, parts, and work, and all related matters (references to products include parts and references to work include construction and installation). Hydro's obligations hereunder are expressly conditioned on Buyer's assent to these terms and conditions. Hydro objects to any terms that are different from, or additional to, these terms and conditions. Any applicable detail drawings and specifications are hereby incorporated and made a part of these Terms and Conditions of Sale insofar as they apply to the material supplied hereunder.

3. **SPECIFICATIONS.** Products are supplied in accordance with information received by Hydro, or its duly authorized agent, from Buyer. Hydro shall have no responsibility for products created or sold based upon inaccurate and/or incomplete information supplied to it. Buyer shall ensure that Hydro receives all relevant information in time to enable it to supply the appropriate products.

4. **INSTALLATION AND APPLICATION OF PRODUCTS.** Products supplied hereunder shall be installed and used only in the application for which they were specifically designed. Buyer should not presume that any products supplied by Hydro may be utilized for any applications other than those specified; nor shall Hydro's obligations, including, without limitation, any warranty obligations, survive Buyer's transfer of products supplied hereunder to third parties unless the products are transferred with Hydro's consent. In addition, Buyer shall not use any product supplied hereunder at any location other than at the location for which Hydro has previously received notice from Buyer. Any breach of any of the foregoing restrictions may amount to an infringement of the patent for the products in question and will in any event void all express or implied warranties relating to the products supplied hereunder.

5. **PURCHASE PRICE AND PAYMENT TERMS.** All prices are in U.S. dollars and all payments shall be made in U.S. dollars. Payment terms are as follows:

	Incremental Payment	Cumulative Payment
Upon Approval of Shop Drawings	10%	10%
Upon Delivery of Equipment to Site	80%	90%
Upon Final Acceptance or 45 days following completion of equipment start up	10%	100%

If payments are not made in conformance with the terms stated herein, any unpaid balance shall be subject to interest at a rate 1½% per month, but not to exceed the maximum amount permitted by law. If shipment is delayed by Buyer, the previously agreed date of readiness for shipment shall be deemed to be the date of shipment for payment purposes. If manufacture is delayed by Buyer, a payment shall be made based on purchase price and percentage of completion, with the balance payable in accordance with the terms as stated. If at any time in Hydro's judgment Buyer may be or may become unable or unwilling to meet the terms specified, Hydro may require satisfactory assurance or full or partial payment as a condition to commencing, or continuing manufacture, or in advance of shipment.

Until payment in full has been received by Hydro, this Standard Terms and Conditions of Sale shall constitute a security agreement and Buyer hereby grants Hydro a purchase money security interest in and to the products produced by Hydro hereunder, and any products or proceeds thereof. In particular:

a. Hydro will retain an express purchase money security interest in and to the products and all proceeds thereof.

b. Until full payment for the products is received by Hydro, Hydro reserves the right to retake possession of the products at any time and for this purpose Buyer authorizes Hydro or its duly authorized agent to enter upon land or premises where it believes the product may be.

c. Proceeds of any disposal of the products shall be held in trust for Hydro pursuant to the terms of the Maine Uniform Commercial Code.

d. Buyer grants Hydro a power of attorney for the purpose of filing a UCC-1 financing statement in the name of Buyer to evidence Hydro's security interest in the products.

6. **BACKCHARGES.** In the event that Buyer is required to make repairs, corrections or modifications to the goods supplied by Hydro, it shall only do so upon written approval from Hydro. Backcharges shall be limited to the costs directly associated in making the repairs, corrections or modifications to the goods supplied by Hydro. The costs of such backcharges shall be subject to approval by Hydro and shall be limited to: (1) directly related labor and material costs, (2) directly related equipment and tool rental at prevailing rates in the project location and (3) Buyer's overhead & supervision costs to make repairs, corrections or modifications to the goods supplied by Hydro. Buyer shall submit complete documentation to Hydro's satisfaction including but not limited to labor time sheets, material lists, and rental fees detailing the nature of the back charges. Backcharges shall be in the form of an adjustment to the contract price or reduction in retained payments and not a direct payment. No incidental or consequential backcharges shall be allowed.

7. **DELIVERY.** The goods are sold DDP (Incoterms 2010) jobsite, freight prepaid to Buyer at job site. Except as outlined in Paragraph 8 below, the risk of loss passes to Buyer after Hydro delivers the goods to the jobsite. Hydro reserves the right to select the method of shipment and carrier. Delivery dates are approximate only and are not a guarantee of delivery on a particular day. Hydro is not liable for failure or delays in deliveries of any cause whatsoever beyond the control of Hydro.

8. **TITLE & INSURANCE:** Title to the product(s) and risk of loss or damage shall pass to Buyer upon delivery to a carrier as outlined in Paragraph 7 above, or, in the event Buyer delays shipment, by the previously agreed date of readiness for shipment, except that a security interest in the product(s) or any replacement shall remain in Hydro's name, regardless of the mode of attachment to realty or other property, until the full price has been paid in cash. Buyer agrees to protect Hydro's interest by adequately insuring the product(s) against loss or damage from any external cause with Hydro named as insured or co-insured.

9. **ERECTION:** Unless otherwise stated in writing, the goods provided hereunder shall be assembled and erected by and at the expense of Buyer.

10. **CANCELLATION & BREACH:** Orders placed cannot be canceled, nor shipments of goods made up, or in process, be deferred beyond the original shipment dates specified, except with Hydro's written consent and upon terms which shall indemnify Hydro against all loss. In the event of cancellation or the substantial breach of Buyer's obligations, as by failing to make any of the payments when due, the parties agree that Hydro will suffer a serious and substantial damage that will be difficult, if not impossible, to measure, both as of the time of entering into this purchase agreement and as of the time of such cancellation or breach. Therefore, the parties agree that, upon such cancellation or breach, Buyer shall pay to Hydro the sums set forth herein below, which sums the parties do hereby agree shall constitute agreed and liquidated damages in such event:

    a. If cancellation or breach shall occur after the acceptance of the purchase order but prior to mailing of submittal documents by Hydro to Buyer, liquidated damages shall be 10% of the selling price.

    b. If cancellation or breach shall occur within thirty (30) days from the mailing of submittal documents by Hydro to Buyer, the liquidated damages shall be 20% of the selling price.

    c. If the cancellation or breach occurs after thirty (30) days from the mailing of submittal documents by Hydro to Buyer, but prior to notification that the order is ready for shipment, the liquidated damages shall be the total of 30% of the selling price plus the expenses incurred, cost of material, and reasonable value of the work expended to fill the order involved herein by Hydro's engineers and other employees, agents and representatives after the mailing of general arrangement drawings by Hydro to Buyer, said sums to be determined at the sole reasonable discretion of Hydro; provided, however, that the total liquidated damages under this provision shall not exceed the total selling price.

    d. If cancellation or breach shall occur after Hydro has notified Buyer that the order is ready for shipment, then the liquidated damages shall be the total selling price, less costs associated with startup or field testing.

11. **MATERIALS OF CONSTRUCTION, PAINTS AND COATINGS:** Buyer is responsible for determining the suitability of, and for giving final approval of, the materials of construction, paints, coatings, etc. to be used by Hydro.

12. **WARRANTY:** Any product that proves defective in material, workmanship or design within twelve (12) months after beneficial occupancy will be, at the discretion of HYDRO, modified, repaired or replaced, or Buyer's payment for the products will be refunded. This shall be Buyer's sole remedy. HYDRO EXPRESSLY EXCLUDES AND DISCLAIMS ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHER WARRANTIES, EXPRESS OR IMPLIED.

    This warranty does not cover any defects or costs caused by: (1) normal wear and tear of equipment from designed operation. (2) modification, alteration, repair or service of the goods by anyone other than Hydro; (3) physical abuse to, or misuse of, the goods, or operation thereof in a manner contrary to Hydro's instructions; (4) any use of the goods other than that for which they were intended; (5) chemicals or components which were not disclosed to Hydro; (6) storage contrary to Hydro's instructions; or (7) failure to maintain the goods in accordance with Hydro's instructions.

    This warranty does not apply to component parts of the goods that were not both originally designed and manufactured by Hydro, including, but not limited to, valves and controls. These component parts do not carry any warranties by Hydro, and only carry the warranties, if any, of their manufacturers.

In order for Buyer to make a claim under this warranty, Buyer must promptly, and within the warranty period, notify Hydro in writing of any defect(s) in the goods covered by this warranty. If any defect(s) in the goods covered by this warranty are visible at the time of delivery, Buyer must notify Hydro of the defect(s) in writing within five working days. To make any claim under this warranty, Buyer must also fully comply with written authorization and return instructions from Hydro.

13. **FIELD SERVICE:** Startup/Field Service will only be scheduled upon written request. Buyer shall notify Hydro of schedule requirements at least ten (10) working days in advance, or additional charges may be added to cover late-scheduled travel costs. Additional costs will be limited to those arising out of late-scheduled costs. Should Buyer have outstanding balances due Hydro, no startup / field service will be scheduled until such payments are received by Hydro. Hydro will send documents to Buyer defining the service or startup requirements. Buyer assumes all responsibility for the readiness of the system when it requests startup service. Should Hydro's Field Service Engineer arrive at the jobsite and determine that the system cannot be started up within a reasonable time, Hydro shall have the option to bring the Field Service Engineer home and bill Buyer for time, travel and living expenses. Additional field service is available from Hydro at the prevailing per-diem rate at the time of the request for service plus all travel and living expenses, portal-to-portal. A purchase order or change order will be required prior to scheduling this additional service.

14. **LIMITATION OF HYDRO'S LIABILITY**. Hydro assumes no liability or responsibility for the misuse of its products by Buyer, Buyer's employees, agents or assigns, or other use inconsistent with the use appropriate to the performance specification requirements submitted to Hydro, and Buyer agrees to indemnify and hold harmless Hydro for any loss, costs, expense or liability that it may incur or be put to as a result of misuse or inconsistent use of the products. In addition, Hydro shall have no liability to Buyer for any consequential or incidental damages incurred by Buyer in connection with the contract documents or the products purchased by Buyer. Hydro shall not be liable for any loss which results from delay in delivery caused by any reason beyond its control, including, but not limited to, acts of God, casualty, civil disturbance, labor disputes, strikes, transportation or inability to obtain materials or services, any interruption of its facilities, or act of any governmental authority. The time for delivery shall be extended during the continuance of such conditions. The total liability of Hydro to Buyer in the form of liquidated damages for any loss, indemnity, damage or delay of any kind will not under any circumstances exceed 25% of the Contract Sum.

15. **INTELLECTUAL PROPERTY**. Hydro shall retain sole ownership of all of its intellectual property used or produced in connection with the Project, including but not limited to all drawings, specifications, software, written materials, manuals, marks, business methods, and all other property that is capable of protection by a patent, copyright or trademark (whether or not such protection has actually been sought). Buyer shall not use such intellectual property except for the purpose of confirming the quality of design and/or manufacturing of the products and services set forth in the Proposal. Buyer shall not photocopy, duplicate or in any way copy such intellectual property except for the Buyer's internal purposes only (but not for rendering services or selling products to third persons). Buyer shall not sell, license, assign or transfer the intellectual property protected by this paragraph to anyone. Buyer shall ensure that Owner is in possession of valid licenses for all third-party software (not provided by Hydro) used for the Project, and shall indemnify and hold harmless Hydro against all claims by licensors of such software. Hydro makes no warranty regarding the effect of such third-party software on the performance of the software to be developed by Hydro for the Project and Hydro shall be released from any warranties given to Buyer to the extent that such software causes or contributes to problems. Following acceptance and final payment to Hydro, Hydro will grant to the Owner a non-transferable, non-exclusive license to use the software for the Owner's internal purposes only in the form of the license agreement attached as Exhibit A. Patent: www.hydro-int.com/patents

16. **TAXES.** Prices stated herein do not include any tax, excise, duty or levy now or hereafter enacted or imposed, by any governmental authority on the manufacture, sale, delivery and/or use of any item delivered. An additional charge will be made therefore and paid by Buyer unless Hydro is furnished with a proper exemption certificate relieving Hydro of paying or collecting the tax, excise, duty or levy in question.

17. **INTERPRETATION OF CONTRACT.** This contract shall be construed according to the laws of the State of Maine.

18. **CHOICE OF FORUM**. Buyer and Hydro hereby consent and agree that the United States District Court for the District of Maine or the District Court or Superior Court located in the City of Portland, County of Cumberland, Maine will have exclusive jurisdiction over any legal action or proceeding arising out of or relating to the contract documents, and each party consents to the personal jurisdiction of such Courts for the purpose of any such action or proceeding. Buyer and Hydro further hereby consent and agree that the exclusive venue for any legal action or proceeding arising out of or relating to the contract documents will be in the County of Cumberland, Maine. Each party hereby waives all rights it has or which may hereafter arise to contest such exclusive jurisdiction and venue.

19. **ATTORNEYS' FEES.** If any judicial or non-judicial proceeding is initiated for the purpose of enforcing a provision of this contract, the prevailing party shall be awarded reasonable attorneys' fees in addition to all other costs associated with the proceeding, whether or not the proceeding advances to judgment.

20. **SEVERABILITY.** If any provisions of this contract are held invalid by a court of competent jurisdiction, the remainder of this contract shall not be rendered invalid, and such invalid provisions shall be modified, in keeping with the letter and spirit of this contract, to the extent permitted by applicable law so as to be rendered valid.

21. **ANTI-BRIBERY.** Hydro International will not engage in any form of bribery or corruption. The offering, giving or receiving of bribes is contrary to Hydro International's values and can play no part in the way in which it carries out its business. Hydro requires you to support our approach and implement provisions consistent with our policy through your own organization and your supply chain. Please find a copy of our Anti-Bribery and Corruption Policy on our website at: https://www.hydro-int.com/sites/default/files/hydro_international_anti-bribery_and_corruption_policy_-_july_2018.pdf

Weir Specialty Pumps

440 West 800 South
Salt Lake City, UT 84101
P.O. Box 209
Salt Lake City, UT 84110

Tel: 801-359-8731
Fax: 801-355-9303
www.weirsp.com

WEMCO®
Pumps & Systems

PROPOSAL

April 4, 2019

SUBJECT: WEMCO PUMPING EQUIPMENT
JOB: Savannah, GA Travis Field WWTP
PROPOSAL NO. 955778

Thank you for your inquiry for WEMCO equipment. We are pleased to offer our quotation as described below:

Scope of Supply – Section 46 23 67 – Grit Removal Pump

Grit Removal Pump

Qty. (1) 4" X 4" MODEL C WEMCO Torque-Flow Pump with clockwise rotation complete with:

- High chrome wet-end materials (case, impeller, & wear-plate)
- Slurry Dynamics flush-less single mechanical slurry seal with tungsten carbide/silicon carbide faces
- 15HP, 284T, 1200RPM, premium efficient, severe duty, inverter duty rated, TEFC motor
- Bent steel base plate with side mount pump & motor arrangement
- Variable speed belts & sheaves – stationary control

Primary design condition: 250 GPM against 20' TDH running at 635 RPM.

Secondary design condition: 375 GPM against 37' TDH running at 860 RPM.

Please refer to the enclosed Technical Offer 955778 Item 001 for further details.

Scope of Supply – Section 46 23 67.1 Grit Classifier

Hydrogritter

Qty. (1) 12" Full Flare WEMCO Hydrogritter with (1) weir end mounted 1000C WEMCLONE designed to handle 250-375 GPM @ 7.5-15 PSI, to include the following:

- 316L stainless steel classifier tank, spiral, tank and cyclone supports, and tank cover guards
- 3/8"stainless steel sluice water valve with NEMA 4X enclosure
- 1/2 HP 1800 RPM TEFC efficiency motor
- Stainless steel spiral belt guards
- WEMCLONE with aluminium cone & apex sections with rubber liner
- Stainless steel WEMCLONE supports and 0-15 PSI pressure gauges with diaphragm seals

Please refer to the enclosed Technical Offer 955778 Item 002 for further details.

Following items are included in the scope:

- Factory certified performance testing (pumps only).
- Factory field start-up and O&M training: (1) trip and (3) days on-site.
- Tnemec high performance coatings.

Following items are NOT included in the scope:

- Piping, fittings, valves, special tools, flush plans/systems, or anchor bolts.
- Controls of any kind, including VFDs, starters, or panels.

Technical Comments:

Section 46 23 67

- 2.01.B: The proposed flows are based on optimal performance for the cyclone, and the associated pump total dynamic heads (TDH) are estimated based on contract drawing M2-2. We recommend verification by the Engineer.
- Primary design condition is 250 GPM against 20' TDH running at approximately 635 RPM. The Secondary design condition is 375 GPM @ 37' TDH running at approximately 860 RPM. The 15 HP motor and variable speed belt drive are sized based on the secondary design condition. A VFD must be used to match the pump speed required for the primary design condition.

Section 46 23 67.1

- 1.07.B: Each cyclone is sized to handle an inlet feed of 250-375 GPM at a pressure of 7.5-15 psi.

Note only Sections 46 23 67, 46 23 67.1 and drawings M2.0A, M2.0B, M2.1, and M2.2 were received for review in the preparation of this proposal. Only those items specifically listed in our quotation will be included. Pricing is subject to change pending the receipt and review of any applicable specifications.

Documentation and Shipment Schedule:

Document submittal:........................4-6 weeks after receipt of order
Shipment:.................................... .14-16 weeks after executed PO and submittal approval

Terms and Conditions

Bid Price:

Pricing is F.O.B. jobsite, Full Freight Allowed. Detailed receiving inspection is required within 72 hours of delivery and notification of damage claims must occur within 5 working days of delivery. No taxes or duties of any kind are included.

Pricing is firm for the shipment(s) indicated, provided the included schedules are maintained.

Payment Terms:

100% Net 30 days. Payment terms in this proposal may not be changed without written authorization from WEMCO. Unauthorized retention of payments by Purchaser for any reason shall be subject to a service charge of 2% per month.

Bid Validity:

This proposal is valid for an order for 60 days from the bid date and based on all conditions herein.

Warranty:

The Warranty included will be per Weir Specialty Pumps Limited Warranty GSD-31 (6/14), or as otherwise noted.

Thank you for the opportunity of submitting our proposal on WEMCO pumping equipment, and if we may be of further service, please contact our representative in your area:

PRINCIPLE ENVIRONMENTAL
1770 The Exchange, Suite 210
Atlanta, GA 30339
Tel: 770-952-9444, Fax: 770-952-7933

Or you can contact this office directly.

Sincerely,

Sincerely,

Robert Haws
Applications Engineer
Weir Specialty Pumps
440 West 800 South (84101)
PO Box 209 SLC Utah 84110-0209
T: 801-530-7861
E: robert.haws@mail.weir

Customer Technical Offer

Customer	PRINCIPLE ENVIRONMENTAL	Size / Stages	4" Model C / 1
Item number	001: Grit Pump	Pump speed	635 rpm
Customer reference		Quote number	955778

Pump

Qty	Description
1	*4" Model C*
	General Pump Options
	Pump Options
	Clockwise rotation (CW)
	Steel pump hardware
	Bearing lubrication
	Oil lubricated bearings
	Nitrile elastomers
	Case Assembly
	4x4 Case
	Vertical Top
	High chrome case (650+ BHN hardness)
	No case vent & drain
	Standard suction connection
	Rotating Assembly
	Rotating Assembly
	High chrome impeller (650+ BHN hardness)
	Static balance
	Steel shaft
	Steel impeller bolt
	Pump Sealing
	Pump sealing
	Seal Type: Single Mechanical Seal
	Slurry Dynamics Single Mechanical Seal Slurry Seal
	No shaft sleeve
	Hi-Chrome Gland Housing Material/Backplate
	Stainless steel gland
	Driver
	Motors
	WSP Supplied Motor: WSP Supplied Motor
	15HP 284T 1200RPM Premium Efficiency TEFC Horizontal Motor
	All motors are sized and selected in accordance with Hydraulic Institute Grade 2 - 2B performance test acceptance grades and tolerances which adds 8% to the rated horsepower requirement of the pump. This calculation has not changed the rated horsepower or efficiency shown on the Performance Data Sheet. View the link for more information from Hydraulic Institute.
	Motor manufacturer - WSP Standard
	Motor options
	Inverter-Rated per NEMA MG 1 Part 31.4.4.2.
	Baseplate and Drive
	Belt Drive Baseplate - Side Mount
	Steel Baseplate
	WSP Standard Baseplate Design
	Steel Baseplate Hardware
	Fiberglass/Polyethylene Guards
	Left Hand Side Mount Motor
	Belts and Sheaves
	Variable Speed Belts and Sheaves - Stationary Control
	Protective Coatings
	Paint type
	Epoxy 3 Coat Paint - Blue (Prime, Intermediate and Top Coat)
	Unless otherwise noted all motors will receive top coat only of specified paint

Pump

Qty	Description
	Packing & Shipping
	Shipping
	No Boxing
	WSP Decision Carrier
	Freight Rates
	Freight Rates - Georgia: Georgia
	Material Testing
	Material Testing
	No Hardness Testing
	No Non-Destructive Testing
	Testing
	Testing
	Testing Required
	Performance Testing
	5 Point Performance Test, Single Speed
	Performance Test: Bare Pump Test
	Customer Approval
	PE Certified
	Start-up
	Start-up
	Factory Field Start-Up and O&M Training: (1) Trip and (3) Days On-site.
	Estimated Weights
	Bareshaft Pump: 890.0 lb
	Baseplate: 440.0 lb
	Driver: 380.0 lb
	Misc. Weight: 0.00 lb
	Misc. Weight: 0.00 lb
	Misc. Weight: 0.00 lb
	Total Per Unit Weight: 1,710.0 lb

Weir Specialty Pumps
www.weirsp.com

Pump Performance Datasheet

Customer	: PRINCIPLE ENVIRONMENTAL	Quote number	: 955778
Customer reference	:	Size	: 4" Model C
Item number	: 001: Grit Pump	Stages	: 1
Service	:	Based on curve number	: 4C_P10C-D56
Quantity	: 1	Date last saved	: 03 Apr 2019 4:08 PM

Operating Conditions

Flow, rated	: 250.0 USgpm
Differential head / pressure, rated (requested)	: 20.00 ft
Differential head / pressure, rated (actual)	: 20.18 ft
Suction pressure, rated / max	: 0.00 / 0.00 psi.g
NPSH available, rated	: Ample
Frequency	: 60 Hz

Performance

Speed, rated	: 635 rpm
Speed, maximum	: 1500 rpm
Speed, minimum	: 600 rpm
Efficiency	: 27.63 %
NPSH required / margin required	: - / 0.00 ft
Ns (imp. eye flow) / Nss (imp. eye flow)	: 1,830 / - US Units
MCSF	: 20.00 USgpm
Head maximum, rated speed	: 23.54 ft
Head rise to shutoff	: 17.66 %
Flow, best eff. point	: 464.7 USgpm
Flow ratio, rated / BEP	: 53.80 %
Speed ratio (rated / max)	: 42.33 %
Head ratio (rated speed / max speed)	: 15.94 %
Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Selection status	: Acceptable

Liquid

Liquid type	: User defined
Additional liquid description	:
Solids diameter, max	: 0.00 in
Solids concentration, by volume	: 0.00 %
Temperature, max	: 68.00 deg F
Fluid density, rated / max	: 1.000 / 1.000 SG
Viscosity, rated	: 1.00 cP
Vapor pressure, rated	: 0.00 psi.a

Material

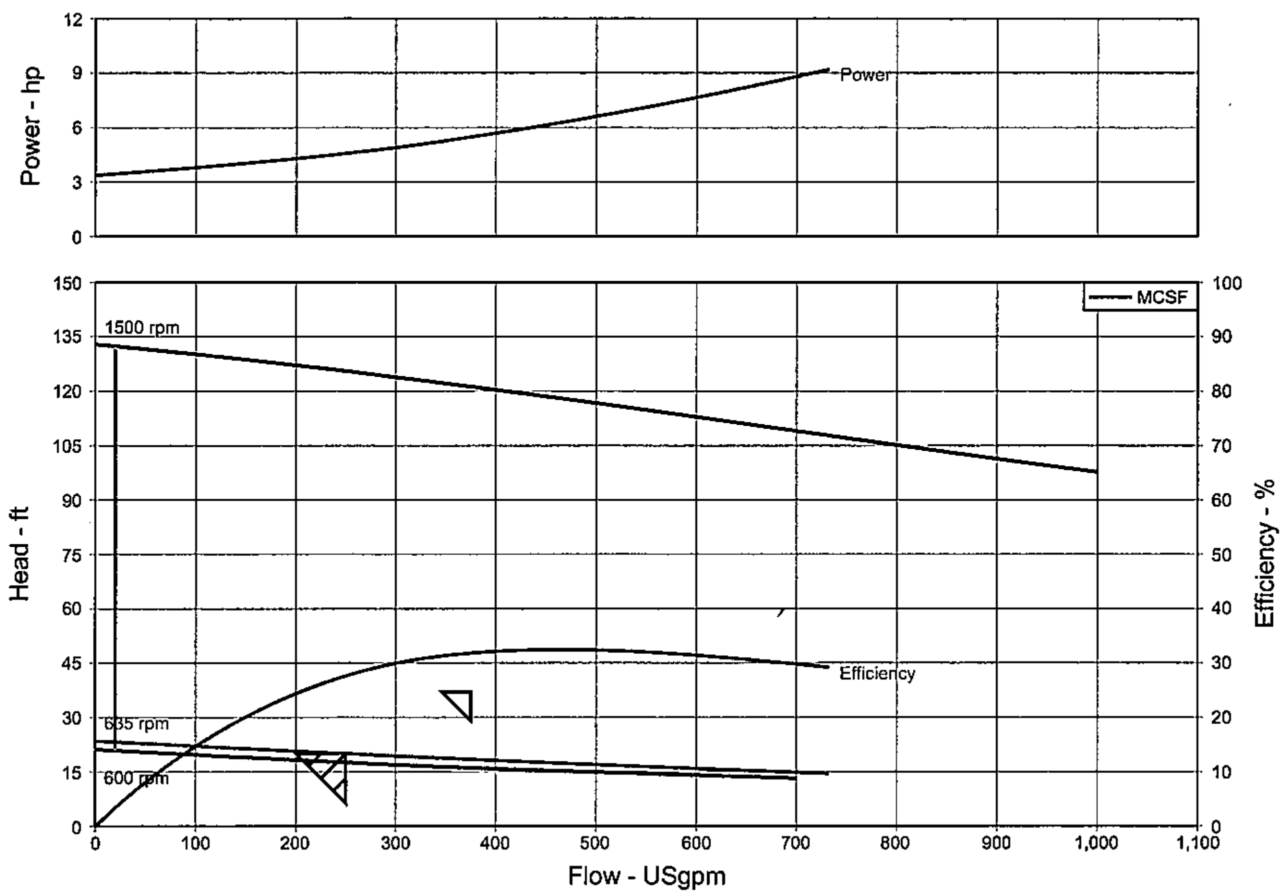
Material selected	: Standard

Pressure Data

Maximum working pressure	: 10.19 psi.g
Maximum allowable working pressure	: 85.00 psi.g
Maximum allowable suction pressure	: N/A
Hydrostatic test pressure	: N/A

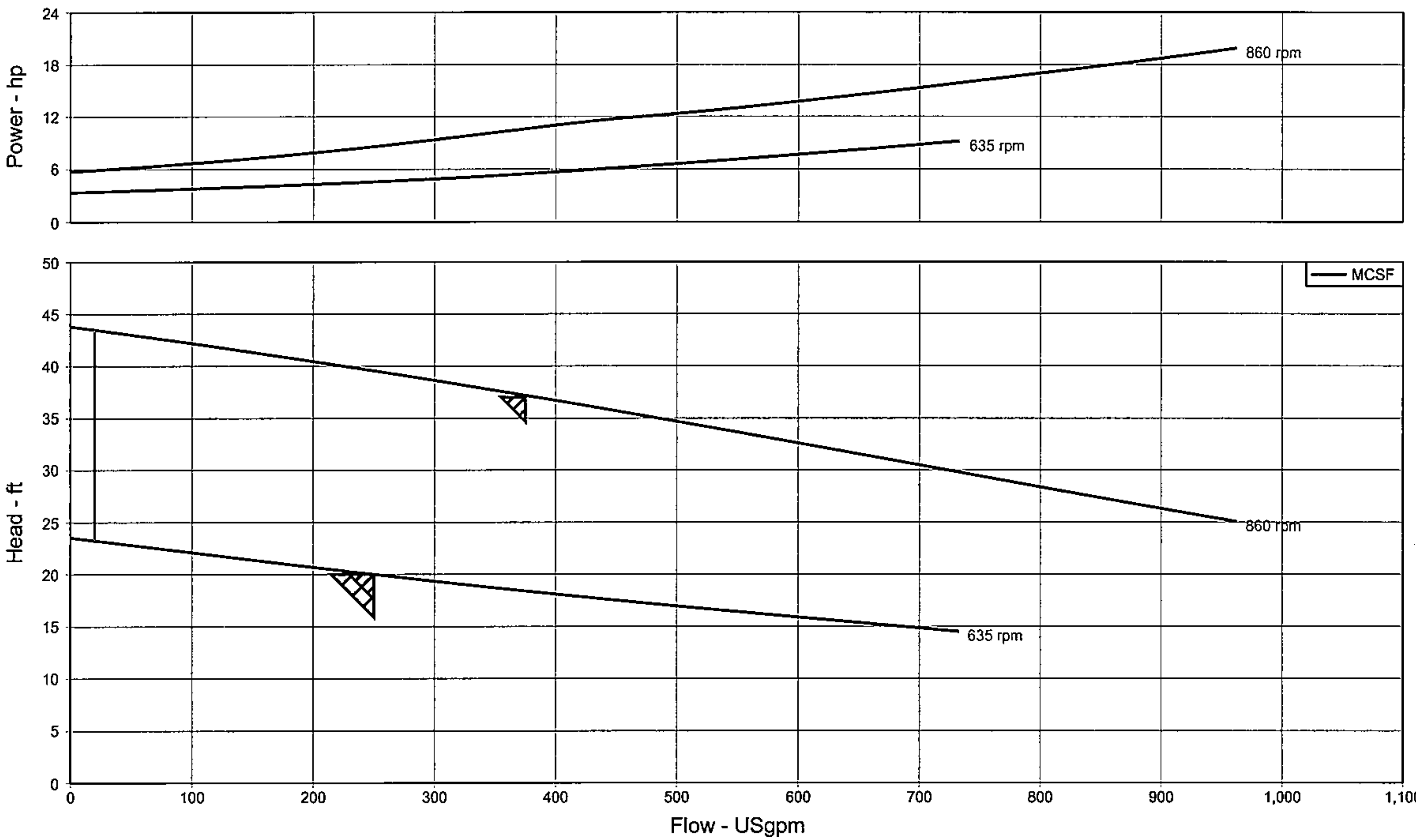
Driver & Power Data (@Max density)

Driver sizing specification	: Rated power
Margin over specification	: 0.08 %
Service factor	: 1.00
Power, hydraulic	: 1.26 hp
Power, rated	: 4.57 hp
Power, maximum, rated diameter	: 9.20 hp
Minimum recommended motor rating	: 5.00 hp / 3.73 kW



Weir Specialty Pumps
www.weirsp.com

Multi-Speed Performance Curve



Customer	: PRINCIPLE ENVIRONMENTAL	Size	: 4" Model C	Flow, rated	: 250.0 USgpm
Customer reference	:	Stages	: 1	Differential head / pressure, rated	: 20.00 ft
Item number	: 001: Grit Pump	Based on curve number	: 4C_P10C-D56	Speed, rated	: 635 rpm
Service	:	Efficiency	: 27.63 %	Fluid density, rated / max	: 1.000 / 1.000 SG
Quantity	: 1	Power, rated	: 4.57 hp	Viscosity, rated	: 1.00 cP
Quote number	: 955778	NPSH required	: -	Cq/Ch/Ce/Cn [ANSI/HI 9.6.7-2010]	: 1.00 / 1.00 / 1.00 / 1.00
Date last saved	: 03 Apr 2019 4:08 PM	Frequency	: 60 Hz		
		Nominal speed	: 1200 rpm		

General Arrangement Drawing

Customer	: PRINCIPLE ENVIRONMENTAL	Quote number	: 955778
Customer reference	:	Size	: 4" Model C
Item number	: 001: Grit Pump	Stages	: 1
Service	:	Pump speed	: 635 rpm
Quantity of pumps	: 1.0	Date last saved	: 03 Apr 2019 4:08 PM

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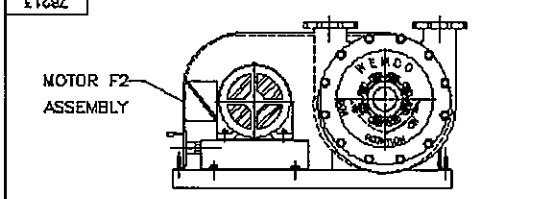
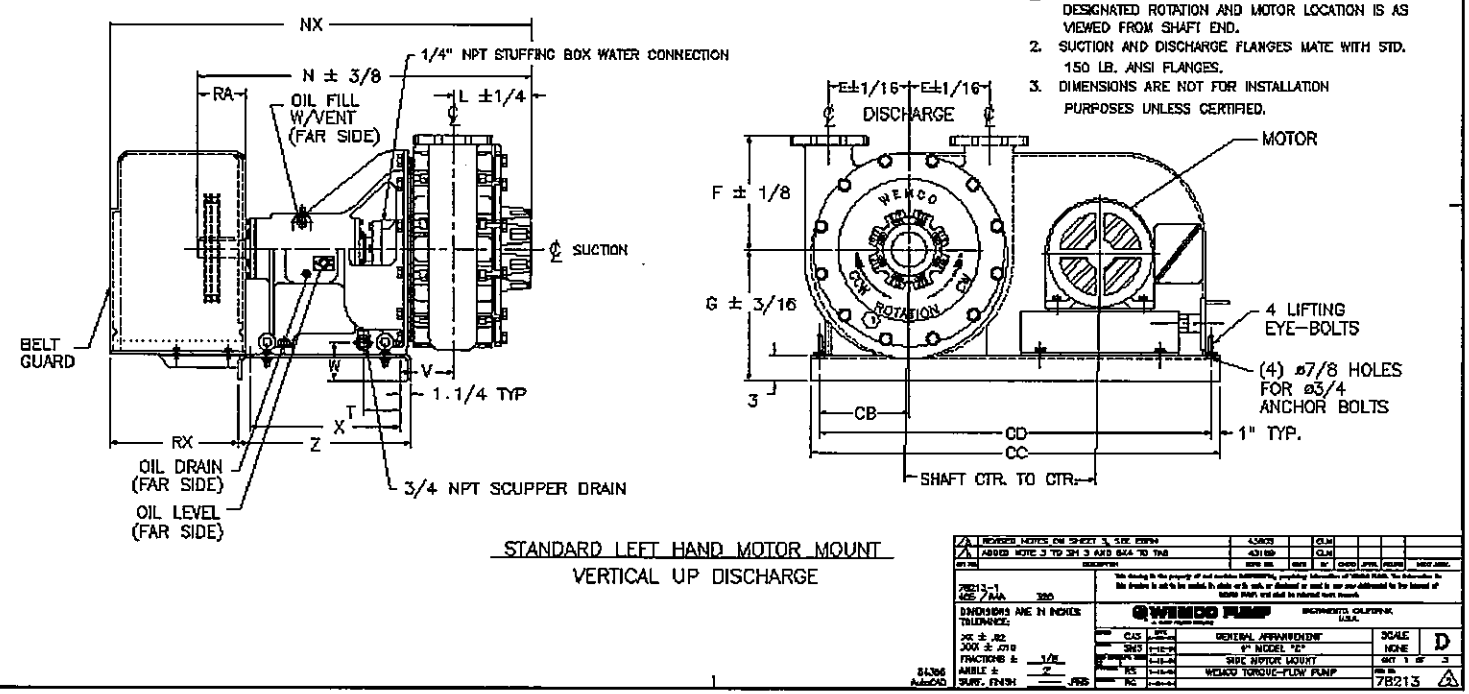


OPTIONAL RIGHT HAND MOTOR MOUNT

PUMP SIZED BY: SUCTION X DISCHARGE / ALL DIMS. IN INCHES

PUMP SIZE	MOTOR FRAME	E	F	G	L	N	NX	V	X	Z	CB	CC	CD	RA	RX	SHAFT CTR.-TO-CTR.	T	W
4X4 OR 5X4	182T - 284T	9 1/4	13	15	9	38 3/16	48 1/2	5 3/4	17 1/2	20	10 1/4	47	45	5 1/2	15	18 1/8 - 23	4	4 1/16
	286T - 365T						48 1/4	3	20	22 1/2	13	60	58			22 5/8 - 31 1/2	6 3/4	
6X4	182T - 284T				12	41 3/16	51 1/2	5 3/4	17 1/2	20	10 1/4	47	45			18 1/8 - 23	4	
	286T - 365T						51 1/4	3	20	22 1/2	13	60	58			22 5/8 - 31 1/2	6 3/4	

NOTES:
1. PUMP AS SHOWN IS AS VIEWED FROM SUCTION END. DESIGNATED ROTATION AND MOTOR LOCATION IS AS VIEWED FROM SHAFT END.
2. SUCTION AND DISCHARGE FLANGES MATE WITH STD. 150 LB. ANSI FLANGES.
3. DIMENSIONS ARE NOT FOR INSTALLATION PURPOSES UNLESS CERTIFIED.



STANDARD LEFT HAND MOTOR MOUNT
VERTICAL UP DISCHARGE

General Arrangement Drawing

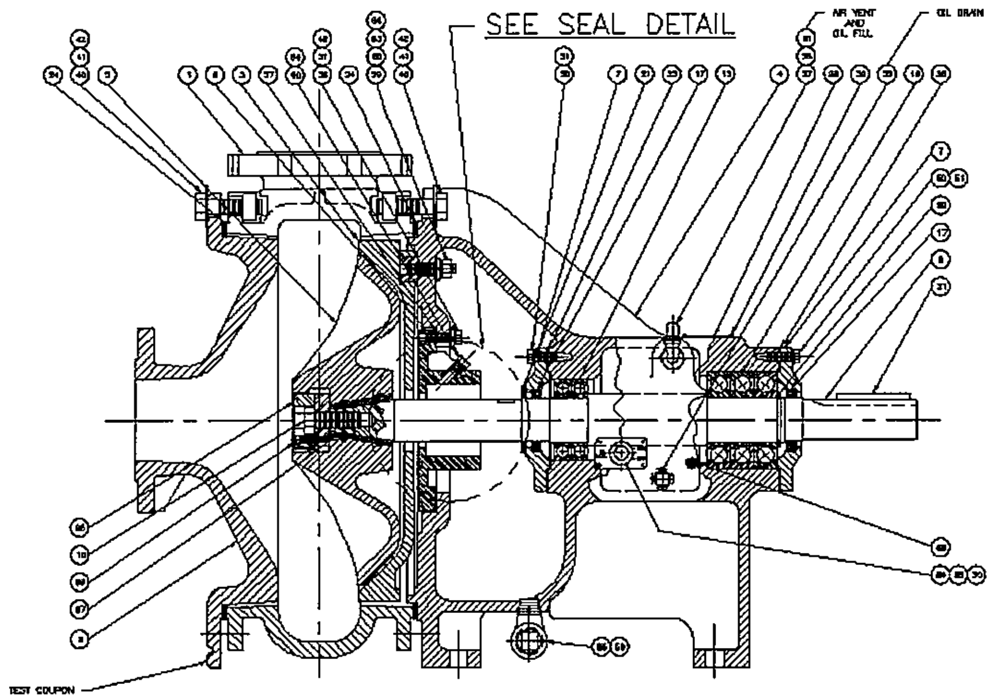
Customer	: PRINCIPLE ENVIRONMENTAL	Quote number	: 955778
Customer reference	:	Size	: 4" Model C
Item number	: 001: Grit Pump	Stages	: 1
Service	:	Pump speed	: 635 rpm
Quantity of pumps	: 1.0	Date last saved	: 03 Apr 2019 4:08 PM

NOTE:

1. ITEMS 64 AND 83 ARE FOR SHIPPING PROTECTION ONLY
2. REFERENCE WEMCO SPECIFICATION 82122 FOR IMPELLER LOCKSCREW TORQUE VALUES.
3. REFERENCE WEMCO DATA SHEET P100-0211.1 FOR BEARINGS INSTALLATION AND SHIMMING. .003/.008 ENDPLAY REQUIRED.
4. PUMP SHOWN WITHOUT PACKING OR SEAL SEE DETAIL DRAWINGS FOR SEAL ARRANGEMENTS.
5. SURFACE PREP AND PAINT THESE PARTS PER PRODUCT STRUCTURE, TRANSMITTAL, OR DEFINITION SHEETS.

QTY	ITEM NO.	PART NO.	DESCRIPTION
1	1		CASE
1	2		IMPELLER
1	3		FLANGE, SUCTION
1	4		HOUSING, BEARING
1	5		WEARPLATE
1	6		HOUSING, GLAND
2	7		CAP, BEARING
1	9		SHAFT
1	10		BOLT, HEX HD
2	15		BEARING, INBOARD
3	16		BEARING, OUTBOARD
2	17		SEAL, OIL

QTY	ITEM NO.	PART NO.	DESCRIPTION
2	20		RING, RETAINING
1	21		SLINGER
2	24		GASKET, CASE
1	25		SHIM, BEARING CAP 1/16" THK
4	26		SHIM, BEARING CAP .002 THK
1	27		GASKET, GLAND HOUSING
1	29		PLATE, SERIAL
8	30		SCREW, DRIVE
1	31		KEY, SQUARE SHAFT
6	33		WASHER, RUBBER
6	37		WASHER, CLIPPED
24	40		BOLT, HEX HD
24	41		WASHER, PLAIN
24	42		NUT, SQ HD
6	48		BOLT, HEX HD
12	50		BOLT, HEX HD
12	51		WASHER, LOCK
1	54		PLUG, PIPE NPTM
1	55		PLUG, PIPE NPTM
1	58		PLUG CAPLUG NPTM
1	57		BUSHING, NPTM
1	58		VENT, AIR
4	59		STUD, TAP END
4	60		NUT, HEX
1	61		ELBOW ST. 90° NPT
4	63		WASHER, CLIPPED
4	64		WASHER, RUBBER
1	83		ELBOW, 90° STREET NPT F X M
1	84		SIGHT WINDOW, LOW PRESR NPT
1	85		NAMEPLATE, OIL LEVEL
1	86		PLUG, PP NPT
1	87		WASHER, THRUST
1	89		PLUG, PP NPT
1	96		COLLAR, LOCKING
2	98		SCREW, SOC HD CAP



4" MODEL 'C' PUMP ASSEMBLY

D 78219 4

Customer Technical Offer

Customer	PRINCIPLE ENVIRONMENTAL	Size / Stages	12-FF-WE / 1
Item number	002: Hydrogritter	Pump speed	0
Customer reference		Quote number	955778

Pump

Qty	Description
1	*WEMCO Hydrogritter 12" Full Flare - Weir End*
	Tank Options
	Tank Options
	Stainless steel tank
	NEMA4X safety stop enclosure
	Stainless steel hardware
	Extended tank support
	Stainless steel tank support
	No grit chute
	Spiral Options
	Spiral Options
	Stainless steel spiral guard
	Stainless steel spiral single pitch
	ARS wear shoes
	Stainless steel spiral hardware
	Spiral speed - 12 RPM
	Drive
	Drive Options
	Stainless steel driven assembly
	No torque limiter
	No zero speed sensor
	Belt driven
	Stainless steel belt guard
	Sluice water
	Sluice Water Options
	Stainless steel sluice water valve
	120V
	NEMA 4 sluice water valve enclosure
	Wemclone
	Wemclone Configuration
	Wemclone quantity
	Single Wemclone
	1000C Wemclone (quantity of 1)
	Aluminum Wemclone
	Rubber Wemclone liner
	Stainless steel Wemclone hardware
	Wemclone overflow piping -02 45 degrees
	Inlet arrangement C
	45 degree Wemclone
	Stainless steel Wemclone pressure gauge
	0-15 PSI Wemclone pressure gauge (single wemclone)
	Feedbox
	Feedbox Options
	Center feedbox
	One stainless steel feedbox
	Motor
	1/2 HP 1800 RPM E-PACT Efficient 230V/460V TENV Severe Duty Motor

Pump

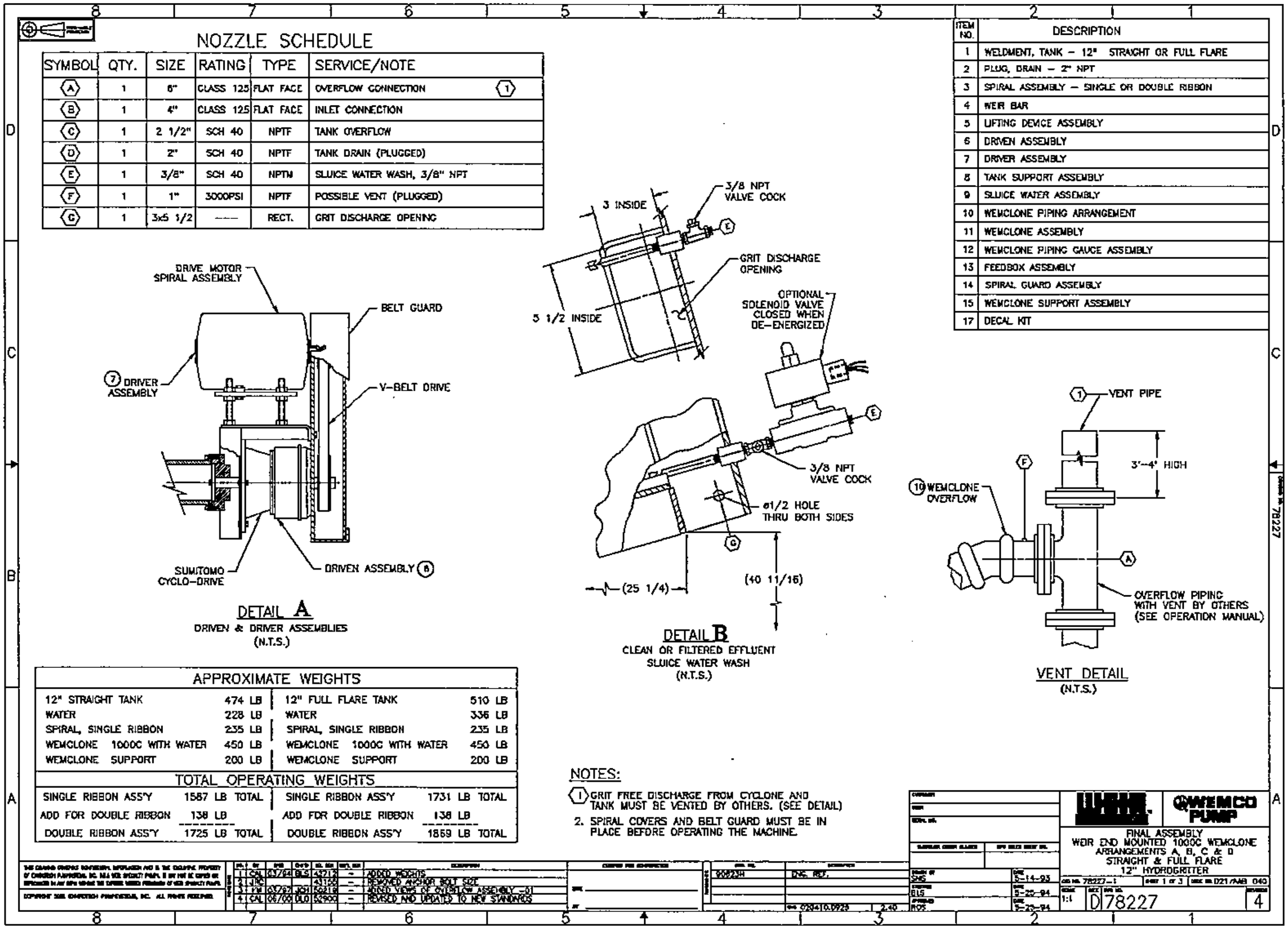
Qty	Description
	Protective Coatings
	Paint type
	Paint Preparation: Standard paint preparation (clean and blast)
	Tank Exterior and Cyclone - Epoxy 2 Coat Paint - Blue (Prime and Top Coat)
	Tank Interior and Spiral - Coal Tar Epoxy Paint - Black
	Stainless steel parts on the Hydrogritter will not be painted
	Packing & Shipping
	Shipping
	No Boxing
	WSP Decision Carrier
	Freight Rates
	Freight Rates - Georgia: Georgia
	Start-up
	Start-up
	Factory Field Start-Up and O&M Training: (1) Trip (3) Days
	Estimated Weights
	Tank: 745.0 lb
	Wemclone: 650.0 lb
	Driver: 30.00 lb
	Misc. Weight: 0.00 lb
	Misc. Weight: 0.00 lb
	Misc. Weight: 0.00 lb
	Total Per Unit Weight: 1,425.0 lb

No Group

Qty	Description
1	Flow Rate/per cyclone 250GPM: 250.0 USgpm
	Inlet Pressure 7.5PSI: 7.50 psi.g

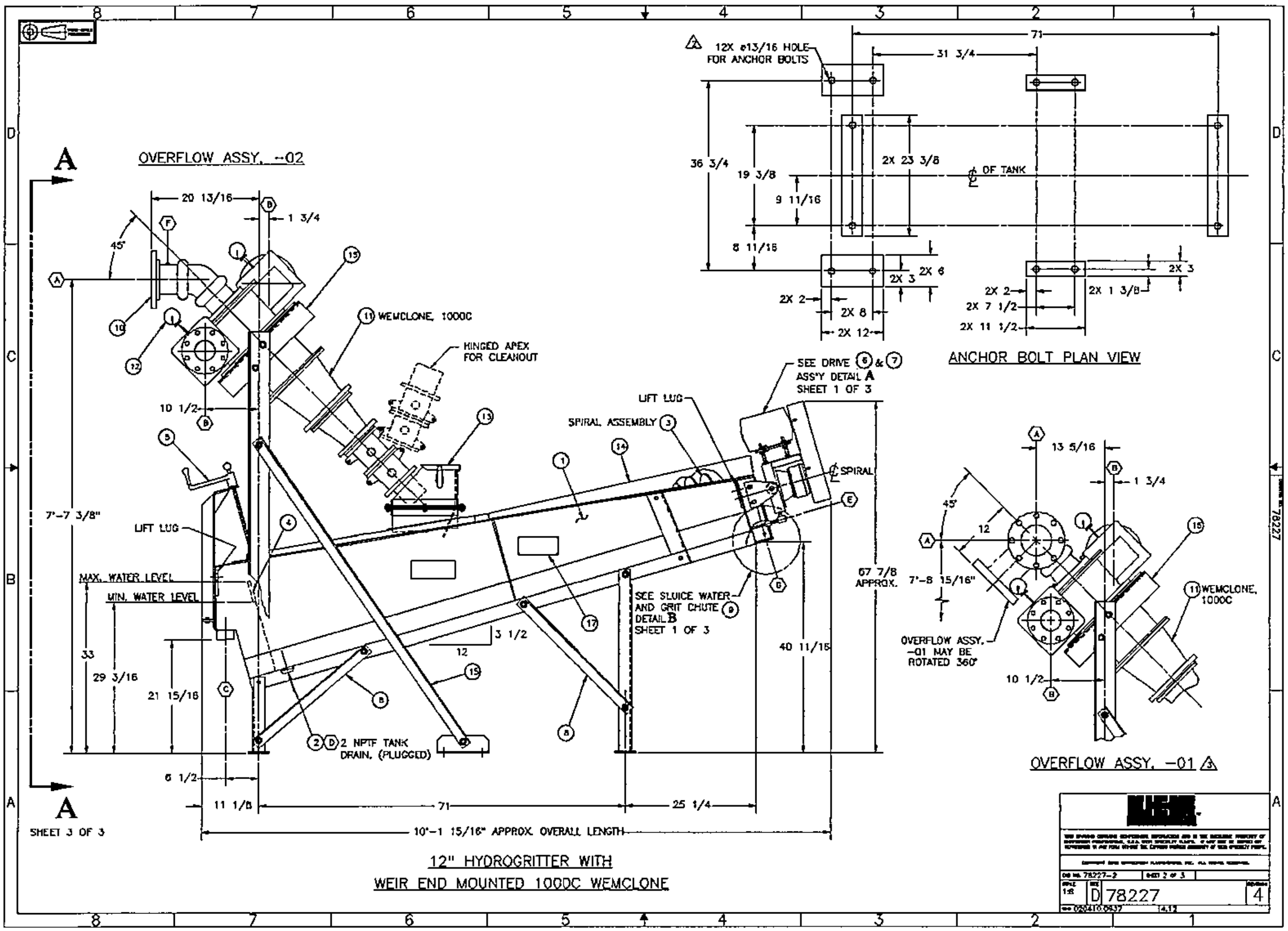
General Arrangement Drawing

Customer	: PRINCIPLE ENVIRONMENTAL	Quote number	: 955778
Customer reference	:	Size	: WEMCO Hydrogritter 12" Full Flare - Weir End
Item number	: 002: Hydrogritter	Stages	: 1
Service	:	Pump speed	: 0
Quantity of pumps	: 1.0	Date last saved	: 03 Apr 2019 2:53 PM



General Arrangement Drawing

Customer	: PRINCIPLE ENVIRONMENTAL	Quote number	: 955778
Customer reference	:	Size	: WEMCO Hydrogritter 12" Full Flare - Weir End
Item number	: 002: Hydrogritter	Stages	: 1
Service	:	Pump speed	: 0
Quantity of pumps	: 1.0	Date last saved	: 03 Apr 2019 2:53 PM



General Arrangement Drawing

Customer	: PRINCIPLE ENVIRONMENTAL	Quote number	: 955778
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Item number	: 002: Hydrogritter	Stages	: 1
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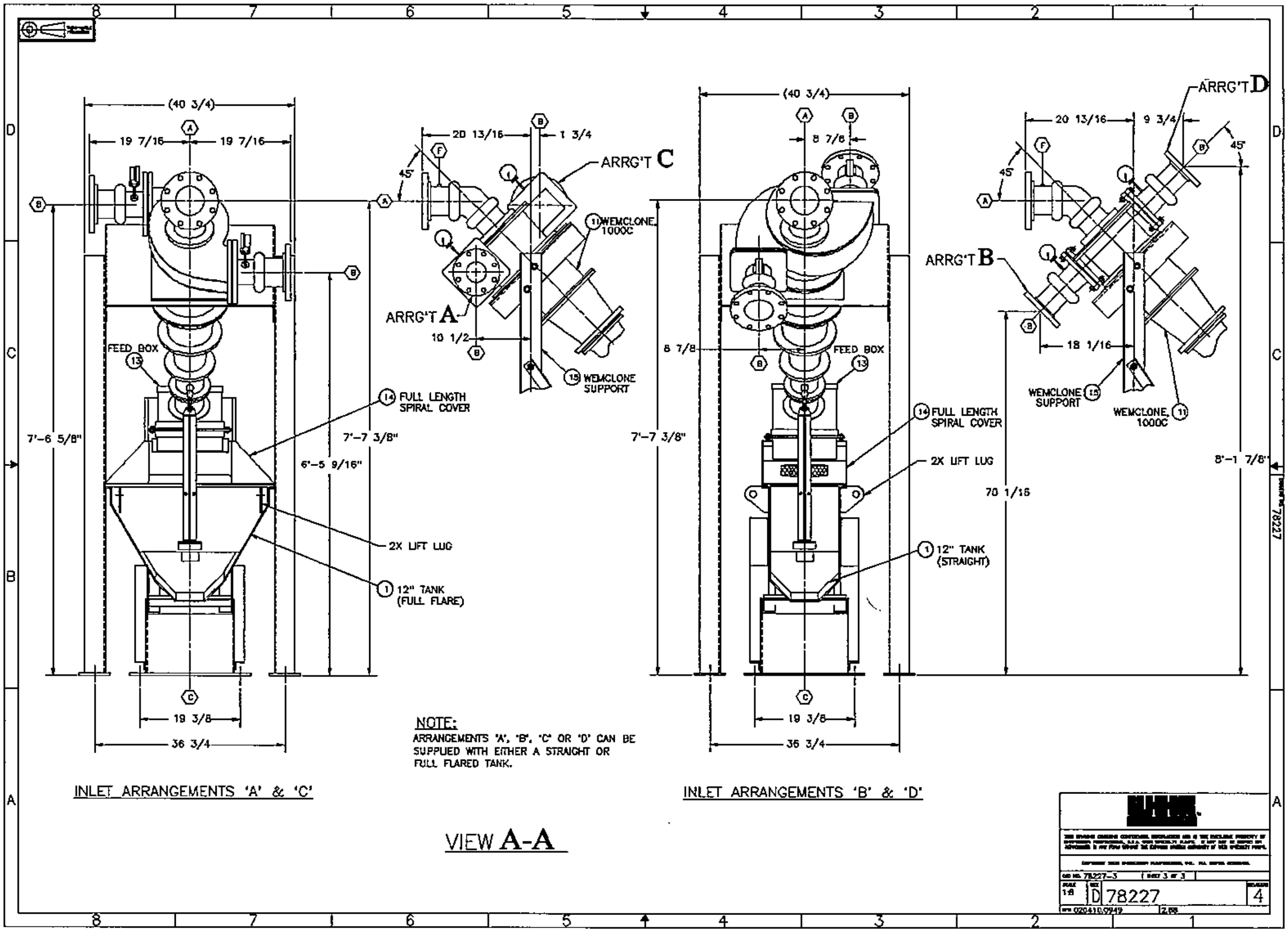

EnviroTech Pumpsystems, Inc d.b.a.

Weir Specialty Pumps (Seller)

An Unincorporated Division of THE WEIR GROUP PLC

GENERAL TERMS and CONDITIONS of SALE

1. SCOPE: Unless otherwise agreed in writing, Seller's acceptance of Purchaser's purchase order is conditioned upon Purchaser accepting these terms and conditions. Seller sells its equipment in accordance with the following provisions.

2. PRICES: Prices are EXW. Prices do not include any federal, state or local sales, use or other taxes and taxes may be added to the price.

3. TERMS: Unless otherwise agreed, all invoices are due and payable in full, net-30 days from date of shipment or notification of readiness to ship, whichever is earlier. Credit terms are subject to Purchaser's credit worthiness, which shall be determined solely by Seller.

Late payments shall be charged interest at the rate of 1.5% per month or the highest rate allowable under law, whichever is less. Purchaser shall pay the full amount, regardless of any payment schedule between Purchaser and its customer.

If Purchaser is in default of any payment Seller may offset any monies of Purchaser available to Seller or in Seller's possession; declare all payments for completed work immediately due and payable; stop all further work until payments are brought current, and/or require advance payment for future shipments.

4. ITEMS INCLUDED: Each sale includes only the equipment described in the order.

Seller shall supply only those safety devices, if any, described in the order or in its proposal and drawings, and shall comply with those provisions of the federal Occupational Health and Safety Act of 1970 that Purchaser and Seller have identified as specifically applicable to the manufacture of the goods..

5. SECURITY INTEREST: To the extent allowable under applicable law, Seller retains a security interest in, and right of repossession, to the goods until Purchaser has paid in full. Purchaser will not encumber, nor permit others to encumber, the goods by any liens or security instruments. In the event legal action is necessary to enforce Purchaser's obligations under any order, Seller shall be entitled to recover its court costs and reasonable attorney's fees if it prevails. Purchaser shall provide insurance for Seller's benefit to protect Seller's interest against loss or damage until is the goods are fully paid for.

6. SHIPMENTS AND DELIVERY: Purchaser must provide Seller all necessary information and instructions regarding its requested delivery schedule, including any required drawing approvals, and Seller shall use its reasonable efforts to meet the shipment dates in the order. However, any such dates are estimates only and are neither guaranteed nor a term of this agreement. Seller shall have no liability to Purchaser or its customer for any damages, whether direct or indirect, for any delay in shipment or delivery, regardless of the severity of the delay.

Unless otherwise agreed, all shipments are EXW Seller's factory, Incoterms 2010, and Purchaser shall make all claims for damage, delay, or shortage arising from any shipment directly against the carrier. When shipments are specified EXW, Purchaser shall inspect the goods, and notify Seller of any damage or shortage within seven days of receipt. Purchaser agrees that failure to so notify Seller shall be deemed as acceptance of the goods.

Unless agreed otherwise in the order, Seller may make partial shipments of completed items for partial payment under the terms of the order.

7. WARRANTY: Seller warrants the goods in accordance with its current applicable Seller's Product warranty, which is incorporated by reference here.

8. PATENTS: Purchaser agrees that it shall indemnify the Seller against all claims, demands, damages, penalties, costs and expenses to which the Seller may become liable by reason of any infringement or alleged infringement of a patent or patents arising out of performance of this order if the equipment is constructed in accordance with Purchaser's detailed drawings or designs submitted to Seller.

9. SUSPENSION OR DELAY: If Purchaser requests a suspension, or delays Seller's work, Purchaser shall pay Seller all reasonable and necessary costs incurred due to the suspension or delay, plus Seller's overhead and reasonable profit. Additionally, all charges and risks for storage, disposition, and/or resumption of work shall be borne solely by Purchaser.

10. LIMITATION OF LIABILITY:
NOTWITHSTANDING ANYTHING ELSE IN THE AGREEMENT TO THE CONTRARY, SELLER SHALL NOT BE LIABLE, WHETHER IN CONTRACT, WARRANTY, FAILURE OF A REMEDY TO ACHIEVE ITS INTENDED OR ESSENTIAL PURPOSES, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, INDEMNITY, OR ANY OTHER LEGAL THEORY FOR LOSS OF USE, REVENUE, SAVINGS, OR PROFIT; COSTS OF CAPITAL; SUBSTITUTE USE OR PERFORMANCE; INDIRECT, SPECIAL, LIQUIDATED, PUNITIVE, EXEMPLARY, COLLATERAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES; CLAIMS BY PURCHASER FOR DAMAGES OF PURCHASER'S CUSTOMERS; OR ANY OTHER LOSSES OR COSTS OF SIMILAR TYPE. "Consequential Damages" shall mean loss or deferral of production, loss of product, loss of use, exclusion and loss of revenue, profit or anticipated profit, cost of capital, overhead, cost of substitute products or services, downtime costs, increased cost of working, loss of contract or business interruption, facility, vessel, or rig downtime, costs relating to cleanup, removal, release or threatened release, remediation, or disposal of or any response to any hazardous material, inability to use property and equipment, losses resulting from failure to meet other contractual commitments, claims of a party's customers for any of the foregoing, and special, incidental, punitive, and speculative damages, as well as indirect losses or damages of any type no matter how characterized.

SELLER'S AGGREGATE LIABILITY TO PURCHASER FOR ALL CLAIMS ARISING OUT OF OR RELATED TO GOODS SOLD OR SERVICES PROVIDED OR OTHERWISE RELATED TO THIS AGREEMENT, WHETHER IN CONTRACT, TORT (INCLUDING NEGLIGENCE), STRICT PRODUCT LIABILITY OR OTHERWISE, SHALL NOT EXCEED FIFTY PERCENT (50%) OF THE TOTAL VALUE OF THE ORDER UNDER WHICH THE CLAIM AROSE. THE FOREGOING LIMITATION SHALL APPLY EVEN IF THE PURCHASER'S REMEDIES UNDER THIS AGREEMENT FAIL OF THEIR ESSENTIAL PURPOSE.

11. CHANGES AND BACKCHARGES: Seller shall not be obligated to make any changes in or additions to the scope of the work unless Seller and Purchaser first agree in writing to the details of the change and any resulting price, schedule or other contractual modifications. Any change to any law, rule, regulation, order, code, standard or requirement which requires any change hereunder shall entitle Seller to an equitable adjustment in the price and time of performance.

Purchaser agrees not to return goods or backcharge for labor, materials, or other costs incurred in modification, adjustment, service or repair of goods unless previously approved in writing by an authorized employee of Seller.

12. CHANGES IN DESIGN: Upon written notification to Purchaser, Seller may modify the design and construction of the goods in order to incorporate improvements or to substitute material equal, or superior, to that originally specified. No charge shall be made to Purchaser for modifications made at Seller's option.

13. DUAL USE ITEMS: In accordance with current U.S. government export rules, items made from Hastelloy C-22 alloy, Hastelloy C-276 alloy, and Inconel 718 alloy, forming part of any order fall into the category of "dual use," for which Seller is required to obtain an export license. If an order includes a dual use alloy, the order will not be considered accepted until the U.S. government has issued an export license. Furthermore, the delivery schedule for any good requiring regulatory approval shall only start once Seller has that approval. If the government denies an export license the order will be considered to have been terminated by Force Majeure.

14. PROPRIETARY INFORMATION: All information furnished by Seller is solely for Purchaser's use in connection with the maintenance and operation of the goods and shall not be disclosed to any third party without Seller's prior, written consent.

15. FORCE MAJEURE: Seller shall not be liable nor responsible to Purchaser, nor be deemed to have defaulted under or breached this agreement, for Seller's failure or delay in fulfilling or performing any of its obligations under this agreement if such failure or delay is caused by, or results from, (a) acts of God; (b) flood, fire, earthquake or explosion; (c) war, invasion, hostilities (whether war is declared or not), terrorist threats or acts, riot or other civil unrest; (d) government order or law; (e) actions, embargoes or blockades in effect on or after the date of this agreement; (f) action by any governmental authority; (g) national or regional emergency; (h) strikes, labor stoppages or slowdowns or other industrial disturbances; (i) shortage of adequate power or transportation facilities; or (j) other events beyond the reasonable control of Seller ("Force Majeure"). Seller shall give Purchaser notice within a reasonable time of the Force Majeure event and shall use reasonable efforts to end the failure or delay and ensure the effects of Force Majeure are minimized. Should there ever be any time of performance it shall be extended for a time period equal to the period of Force Majeure and its consequences.

16. GOVERNING LAW: This agreement shall be interpreted in accordance with the laws of the State of Utah, U.S.A., without regard to its conflicts of laws rules. The application of the United Nations Convention on Contracts for the International Sale of Goods is excluded. Purchaser shall comply with all applicable laws. Seller and Purchaser irrevocably and unconditionally consent to, and submit_themselves to, the exclusive jurisdiction of the state or federal courts of Salt Lake County, Utah, as the exclusive jurisdiction and venue for the resolution of conflicts arising from or pursuant to this agreement.

17. INDEMNITY: Seller shall indemnify, defend and hold Purchaser harmless from any claim, cause of action or liability incurred by Purchaser as a result of third party claims for personal injury, death or damage to tangible property, to the extent caused by Seller's negligence. Seller shall have the sole authority to direct the defense of and settle any indemnified claim. Seller's indemnification is conditioned on Purchaser (a) promptly, within the warranty period, notifying Seller of any claim, and (b) providing reasonable cooperation in the defense of any claim.

18. U.S. EXPORT COMPLIANCE: Furthermore, as Purchaser acknowledges that Seller is required to comply with applicable export laws and regulations relating to the sale, exportation, transfer, assignment, disposal, and usage of the goods provided under the order, including any export license requirements. Purchaser agrees that such goods shall not at any time directly or indirectly be used, exported, sold, transferred, assigned, or otherwise disposed of in a manner that will result in non-compliance with such applicable export laws and regulations. It shall be a condition of Seller's continuing performance of its obligations that compliance with such export laws and regulations be maintained at all times. Purchaser agrees to comply with all applicable export laws and regulations of the U.S. Commerce, Treasury, State and Defense Departments or other agency regulating exports from the United States. Purchaser agrees it will not export, re-export or permit the re-export of any Seller good to an ultimate destination of a restricted and/or embargoed country listed by the Department of State, Department of Commerce or the Department of Treasury and/or restricted and/or individuals on the Directorate of Defense Trade Controls' Debarred List and Nonproliferation Sanction List, Bureau of Industry and Security's Denied Person's List, Entity List and Unverified List and the Office of Foreign Assets Control's Specially Designated Nationals List or any other U.S. government list. Nor will Customer export, re-export or permit the re-export of any Seller good for any prohibited uses under the U.S. export laws.

To the extent that Purchaser subcontracts its services or utilizes agents or third-parties with respect to the provision of the Services to Seller, Purchaser shall incorporate the obligations of this provision with respect to export compliance into its respective subcontracts and agreements with such sub-contracted agents and third parties. All contracts entered into by Purchaser with agents, affiliates, or third-parties, must also include a specific requirement to comply with all laws and regulations (including U.S. export laws).

PURCHASER AGREES TO INDEMNIFY AND HOLD SELLER HARMLESS FROM ANY AND ALL COSTS, LIABILITIES, PENALTIES, SANCTIONS AND FINES RELATED TO NON-COMPLIANCE WITH APPLICABLE EXPORT LAWS AND REGULATIONS.

19. ENTIRE AGREEMENT: This proposal expresses the entire agreement between the parties hereto and supersedes any previous communications, representations, or agreements, whether oral or written, and is not subject to modification except in writing, signed by an authorized officer of each party.

EnviroTech Pumpsystems, Inc d.b.a.

Weir Specialty Pumps (WSP)

An Unincorporated Division of THE WEIR GROUP PLC

LIMITED WARRANTY

COVERAGE: WSP (Seller) warrants its products to be free from defects in materials and workmanship when operated under the normal conditions for which the products were designed.

WARRANTY PERIOD: This warranty covers a period of twelve (12) months from the date product was placed into service, or eighteen (18) months from the date of shipment, whichever occurs first.

REMEDIES: If the product fails due to defective materials or workmanship within the warranty period, WSP's sole obligation after verification of the defect, shall be at its discretion the repair or replacement of the product. THIS PARAGRAPH PROVIDES THE EXCLUSIVE REMEDIES FOR ALL CLAIMS BASED ON FAILURE OF OR DEFECT IN A PRODUCT, WHETHER THE FAILURE OR DEFECT ARISES BEFORE, DURING, OR AFTER THE APPLICABLE WARRANTY PERIOD AND WHETHER A CLAIM, HOWEVER DESCRIBED, IS BASED ON CONTRACT, WARRANTY, INDEMNITY, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, OR OTHERWISE, AND IS SUBJECT TO ALL LIMITATIONS OF LIABILITY FOUND HERE OR ELSEWHERE IN THE TERMS AND CONDITIONS.

OWNER'S OBLIGATIONS: Owner shall notify Seller of a defect within ten (10) days of its discovery. At Owner's expense, the defect may be verified at Owner's site, at Seller's authorized facility, or by returning the product to Seller's factory.

EXCLUSIONS: This warranty does not apply to consumable items that are normally replaced during maintenance; and defects resulting from improper installation, operation, maintenance, storage, neglect, or accident. This warranty does not cover any expense for repairs or alteration performed outside Seller's factory without Seller's prior authorization. Equipment and accessories not manufactured by Seller are warranted only by the original manufacturer's warranty. Seller shall not be liable for costs of removal, transportation, or reinstallation of products. Seller shall not be liable for any consequential, special, incidental, or indirect damages or delays resulting from or related to defective products.

SELLER MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, AND DISCLAIMS ALL IMPLIED WARRANTIES INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, AND ANY IMPLIED WARRANTY THAT COULD ARISE FROM COURSE OF DEALING OR USAGE OF TRADE. SELLER ALSO DISCLAIMS ALL STATUTORY WARRANTIES.

GSD-31 Rev. June 2014

Parkson
Treating Water Right

Quotation

NUMBER:	B06100387	**DATE:**	April 12, 2019
TO:	Thomas & Hutton Attn: Mr. Fred Sororian, P.E.	**REF.:**	Savannah, GA Travis Field WRF Specification Section 44 43 34- Influent Drum Screen Specification Section 44 43 34.1- Screenings Washer/Compactor

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Parkson Corporation is pleased to provide a quotation for the following equipment. The quotation is based upon receipt of Specification Sections 44 43 34 and 44 43 34.1 as well as Plan Drawings M2.0A, M2.0B, M2.1, M2.2 and M2.3. If other specification sections or plan drawings necessitate changes to this quotation, Parkson reserves the right to modify the price listed.

ITEM 1 EQUIPMENT

Three (3) Rotoshear® PF EZ Care internally-fed rotary drum screens model RDS60120DVT

1.A Basis of Design: (Influent Description)

Application:	Raw sewage screening
Peak flow:	7.5 MGD peak flow per unit

Spray wash pressure at the unit must be 80 psi minimum

1.B Equipment Description:

1. Screen cylinder with panels constructed of type 316 stainless steel with 2 mm perforated screen openings.
2. Base frame fabricated with type 316 stainless steel structural members.
3. Headbox assembly fabricated of 10 gauge type 316 stainless steel, with a 24.00" O. D. inlet pipe stub with type 316 stainless steel flanged connection.
4. Drain pan with legs fabricated of 12 gauge type 316 stainless steel, with a 30.00" O. D. bottom outlet pipe stub with type 316 stainless steel flanged connection.
5. Splash guards constructed of 16 gauge type 316 stainless steel.
6. Cover hood to enclose the top of the screen assembly, fabricated of 14 gauge type 316 stainless steel.
7. Discharge end enclosure fabricated of 12 gauge type 316 stainless steel, with chute extension to feed into the screenings wash press inlet chute.
8. Trunnion wheels (4 per unit) made of 8" diameter UHMW polyethylene, fitted with sealed bearings and mounted on stainless steel shafts.
9. Internal and external spray systems made of type 316 stainless steel with 1-1/2" NPT connections.
10. Brass body solenoid valves (2 per unit) in a NEMA 4X enclosure for control of the spray wash systems.
11. Cylinder stabilizing assembly mounted at the discharge end of the cylinder, constructed of type 316 stainless steel bracketing and plastimeric guide.
12. Drive assembly consisting of a 2 HP TEFC gearmotor (230/460/3/60), plastic drive and driven sprockets, and NH78 plastic drive chain.
13. Safety interlock switching mounted on splash guards, rated NEMA 4X.
14. E-stop pushbutton housed in a NEMA 4X polycarbonate enclosure.
15. Zero speed switch in a NEMA 4X enclosure.

Parkson
Treating Water Right

16. Main control panel, quantity of one (1), furnished in a NEMA 4X type 316 stainless steel enclosure, housing controls for three (3) rotary drum screens and three (3) wash press units, with space inside the panel for the future addition of controls for a fourth rotary drum screen and wash press. To include motor starters, control transformer, main disconnect, programmable relay, and all other necessary switches, lights, and pushbuttons for a complete operating system.

Three (3) Aqua Wash Press units model AWP8-2

1.C <u>Equipment Description:</u>

1. The Aqua Wash Press units will consist of a spiral, trough, support legs, wash zone, trough flush spray, press zone, drive system and controls.
2. The units will be designed to receive and wash screenings, then reduce the volume and water content by means of a pressing zone.
3. The press will have an inlet capacity of 35 cu.ft./hour, handling wet screenings with an approximate dry weight of not less than 8% solids.
4. The shafted spiral will be constructed of carbon steel, with an O.D. of 8" and having 0.63 inch thick flights. A brush will be bolted to the spiral in the inlet area to scour the perforated sheet.
5. The trough will be fabricated of type 316 stainless steel, having 0.12 inch diameter perforations, chamfered on the outside. It will receive free liquid from the washed solids and direct the flow to a 4 inch O.D. drain tube. A stand will be provided to elevate the unit as shown on the drawings.
6. The inlet area, 11 inches wide by 27 inches in length, will receive incoming materials.
7. The wash zone will include a spray wash system to wash organic residue from the screenings.
8. The press will include a spray wash system to flush organic residue trapped in the trough.
9. The unit's drive system will consist of a motor, gear reducer and drive shaft. The motor will be 3 HP TEFC, 1800 RPM, 230/460 volt, 3 Phase, 60 Hz. The gear reducer is a shaft-mounted worm type gear reducer driven by a direct-coupled motor. The reducer will have a cast iron housing and output speed of 14 RPM and the drive shaft will be direct coupled to the spiral.
10. In addition to the drive motor, the following electrical devices will be furnished:
    -Two (2) 120 volt, single phase, 60 Hz brass body solenoid valves housed in NEMA 4X enclosures.
    - E-stop pushbutton housed in a NEMA 4X polycarbonate enclosure.
11. Inlet chute of 12 gauge type 316 stainless steel construction, to receive screenings from the screen discharge chute.
12. Discharge piping with support of 14 gauge type 316 stainless steel, to direct the washed and compacted screenings to the required location.
13. Screenings bagger attachment.

Parkson
Treating Water Right

ITEM 2 SERVICES

2.A Drawings and Installation, Operation and Maintenance (IO&M) Manuals:

1.	Approval drawings:	6 prints included
2.	Certified drawings:	6 prints included
3.	IO&M manuals:	6 included

2.B Start-Up Assistance:

Parkson will furnish a factory representative for a total of four (4) days during one (1) trip to the jobsite to assist in installation inspection, start-up supervision, and operator training. Dates of service to be scheduled upon Purchaser's written request. Total is inclusive of all products listed above.

2.C Mechanical Warranty:

Per Section XVI of the Standard Conditions of Sale, with the period not to exceed 18 months from delivery of equipment.

PURCHASE PRICE:

All of the above for .... $761,127.00.
F.O.B. shipping point, freight allowed to jobsite, taxes excluded.

VALIDITY:

Purchase Price is valid for 60 days from quotation date, for shipment of equipment within the timetable stated below.

PAYMENT TERMS:

90% net 30 days after shipment, 10% not to exceed 120 days after delivery.

TIMETABLE GUIDELINE:

Within ten (10) business days of receiving a written Purchase Order in Parkson's office, if necessary, Parkson will submit a written Request for Additional Information requesting items including, but not limited to, full-scale drawings, specification sections, amendments and other documents necessary for Parkson to begin work on this Project. No work can be done on this Project until all Additional Information is received by Parkson, thus beginning the Submittal Phase. If you do not receive such a Request for Additional Information within the stated ten (10) business days, then the Submittal Phase will begin on the eleventh (11th) business day following receipt of the written Purchase Order in Parkson's office. The Shipment Phase is thereafter contingent upon your final approval of all submitted Approval Drawings. Once said final approval is received in Parkson's offices, the Shipment Phase will begin.

Submittal Phase:	Approval drawings will be submitted six (6) weeks from receipt of all requested Additional Information if necessary, or if not necessary, from the eleventh (11th) business day following receipt of a written Purchase Order in Parkson's office.
Shipment Phase:	Twenty (20) weeks following receipt of final approval of all submitted Approval Drawings in Parkson's office.

If the Submittal Phase is waived, the Shipment Phase will begin on receipt of all requested Additional Information if necessary, or if not necessary, on the eleventh (11th) business day following receipt of a written Purchase Order in Parkson's offices.

Dates are subject to confirmation upon receipt of written Purchase Order.

Parkson
Treating Water Right

TERMS AND CONDITIONS:

This Quotation is governed by and subject to Parkson's Standard Conditions of Sale, which are incorporated by reference and accessible at: *http://www.parkson.com/files/documents/Sales-conditions.pdf*.

BUYER/OWNER RESPONSIBILITY:

- Spare parts.
- Anchor bolts.
- Washwater booster pump.
- Concrete or steel support structure or pads.
- Local disconnects or junction boxes.
- Control panel mounting.
- Spray wash water connection and piping.
- Heat tracing or power for heat tracing of spray wash piping.
- Drain piping.
- Pressure gauges.
- Isolation and pressure regulating valves.
- Gate valves, check valves, butterfly valves, ball valves, Y-strainers.
- Portable steam cleaner.
- Screenings dumpster.
- Lubricants.
- Shop or field painting.
- Influent and effluent connection: Units are provided with loose flanged connections. Piping should be supported independent of the unit.
- Unloading, uncrating, installation and installation supervision. Installation will, at minimum, require a forklift and possibly a crane/hoist.
- Readiness of the equipment before requesting start-up service. Non-readiness may incur additional charges.
- Electrical connection and interconnecting wiring (including any of the following: E-Stop buttons, solenoid valves, interlock switches, motors, main control panel); wiring and conduit from each unit-mounted electrical device to a terminal box or control panel.
- Interconnecting piping.
- Piping connections, access platforms, ladders, gratings and railings unless stated otherwise.
- Determining the compatibility of equipment materials of construction and process conditions (air and water) is the responsibility of the owner and/or consulting engineer. Note that even relatively low levels of H2S and/or Chlorides can cause corrosion of 304SS and thus it is important for the owner and/or consulting engineer to pay particular attention to materials suitability for the specific water/wastewater in which the equipment will be operated. Higher grades of stainless steel like 316 are options.
- Any other auxiliary equipment or service not detailed above.

Parkson
Treating Water Right

Please return one signed copy of this Quotation, or your Purchase Order, to Parkson Corporation at the address below. Refer to this Quotation, date, and related correspondence.

Issued By:

PARKSON CORPORATION
562 Bunker Court
Vernon Hills, IL 60061

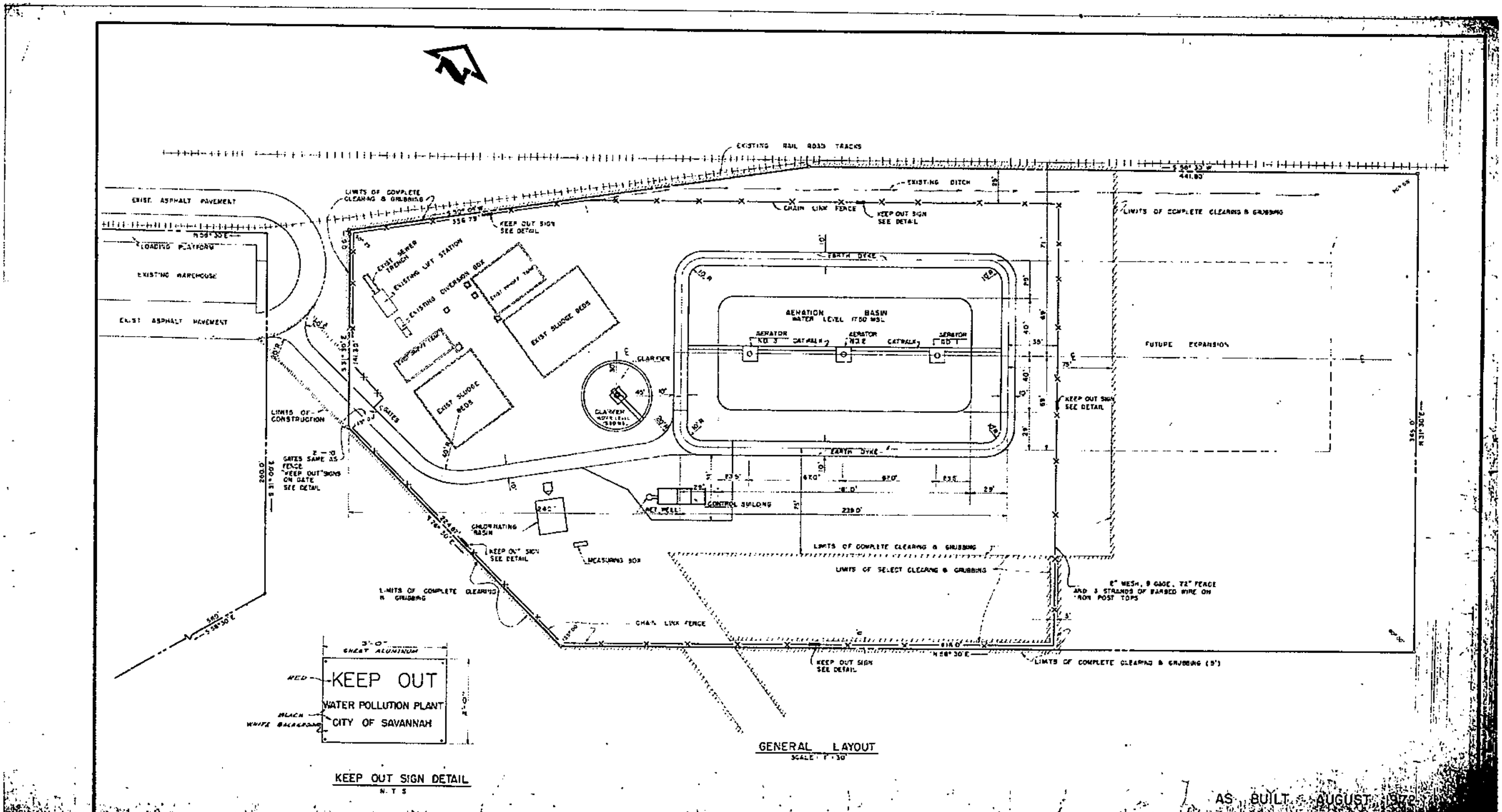
Joseph G. Nagel

Name: Joseph G. Nagel
Title: Municipal Sales
Date: April 22, 2019

Accepted By: (Herein called the Buyer)

Name
Title:
Date:

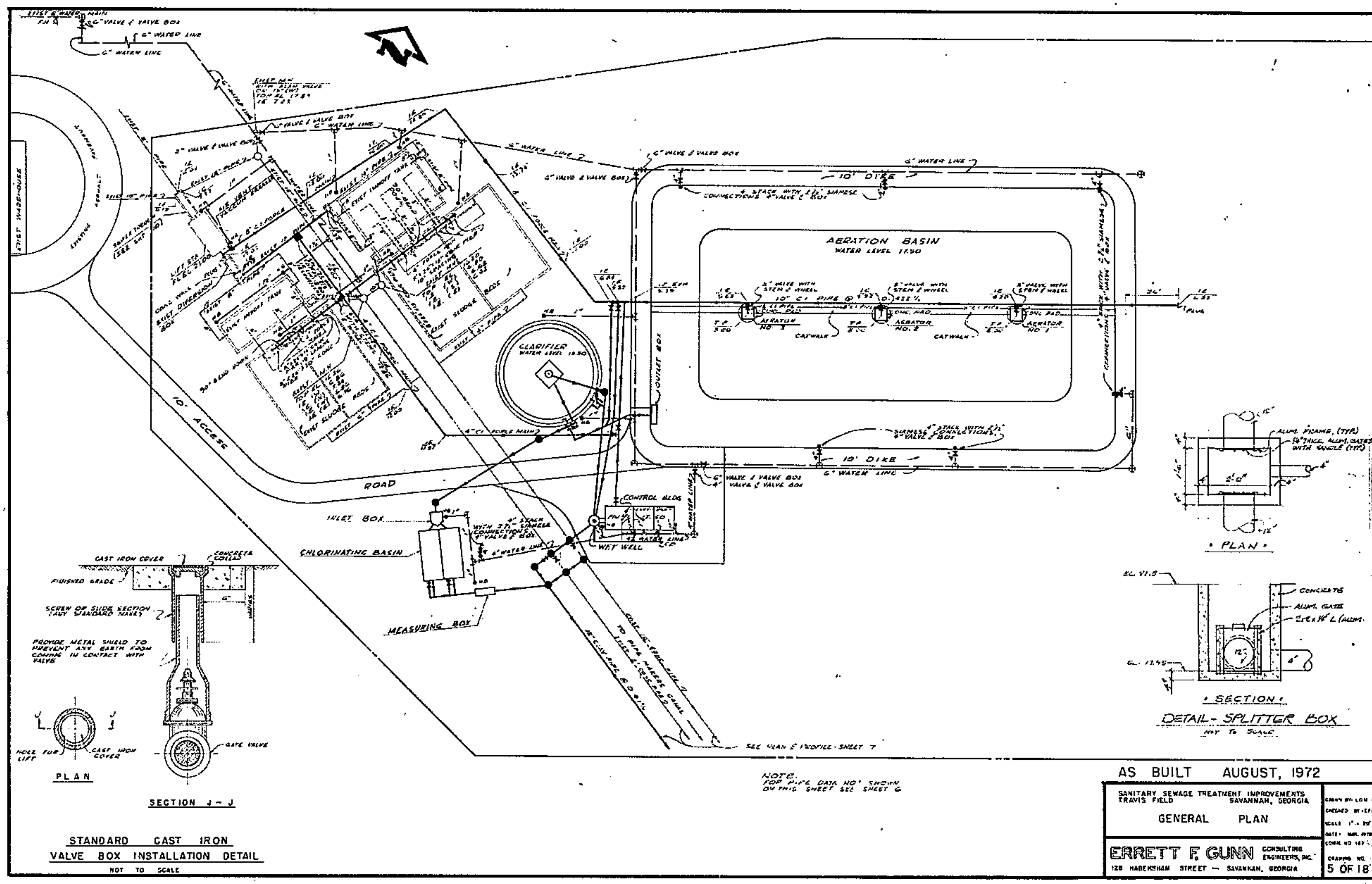
1972 Travis Field Expansion Plans



GENERAL LAYOUT
SCALE: 1" = 30'

KEEP OUT SIGN DETAIL
N. T. S.

AS BUILT - AUGUST 1972



AS BUILT AUGUST, 1972

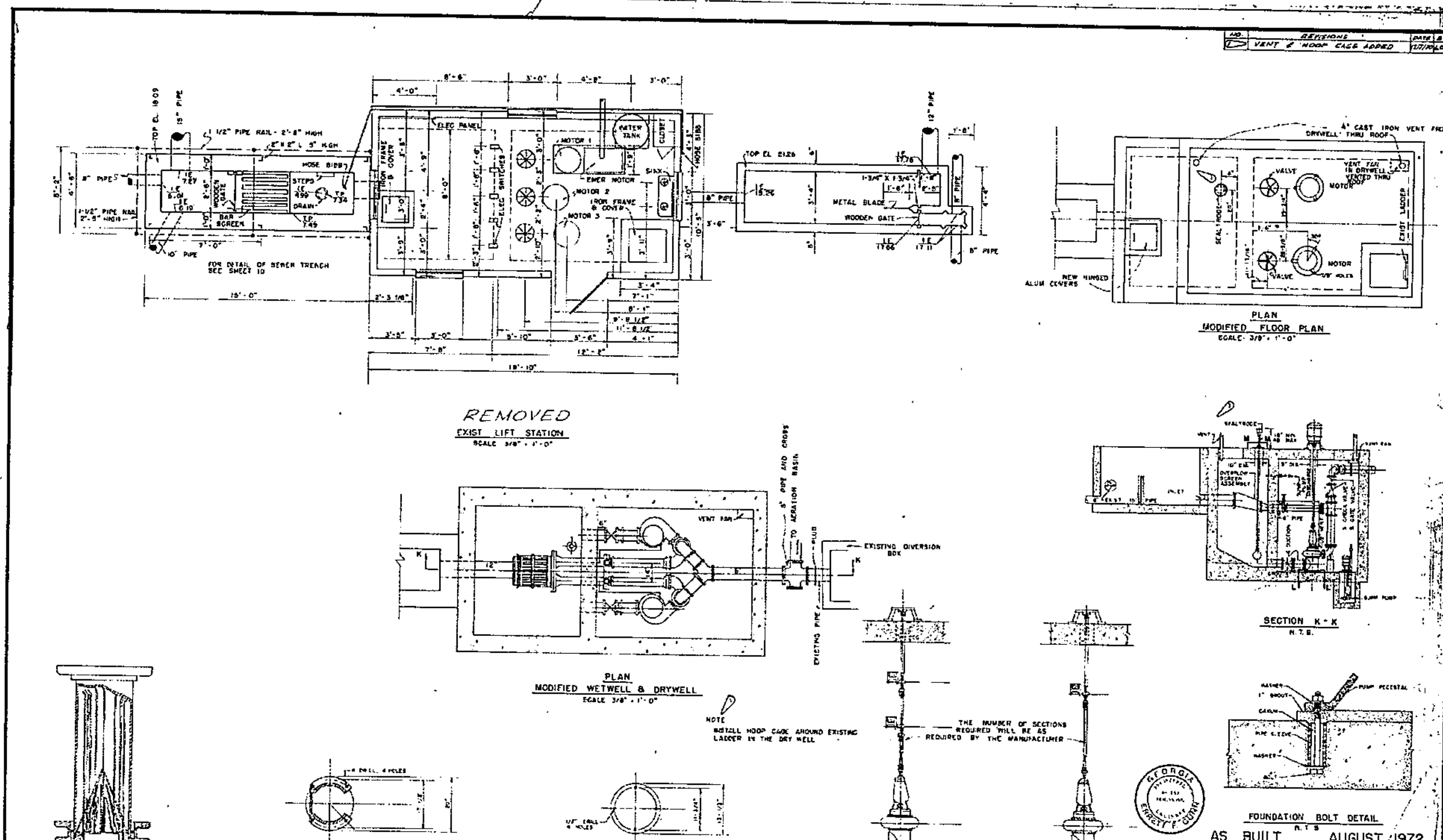
SANITARY SEWAGE TREATMENT IMPROVEMENTS
TRAVIS FIELD SAVANNAH, GEORGIA

GENERAL PLAN

ERRETT F. GUNN CONSULTING ENGINEERS, INC.
128 HABERSHAM STREET — SAVANNAH, GEORGIA

5 OF 18

Z - 49



AS BUILT AUGUST 1972

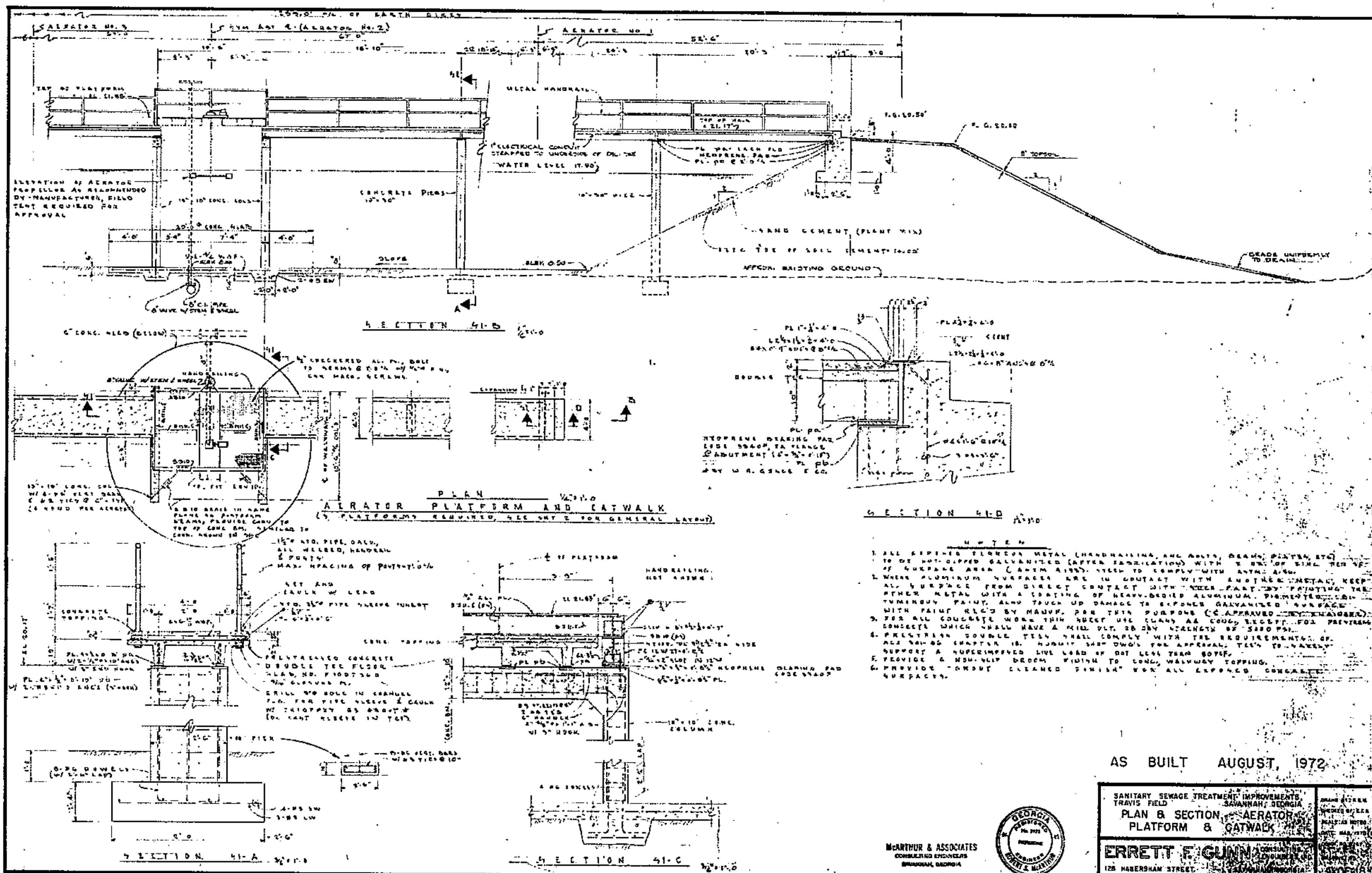
SANITARY SEWAGE TREATMENT IMPROVEMENTS
TRAVIS FIELD
SAVANNAH, GEORGIA

PLAN, SECTIONS, & DETAILS
MODIFIED LIFT STATION

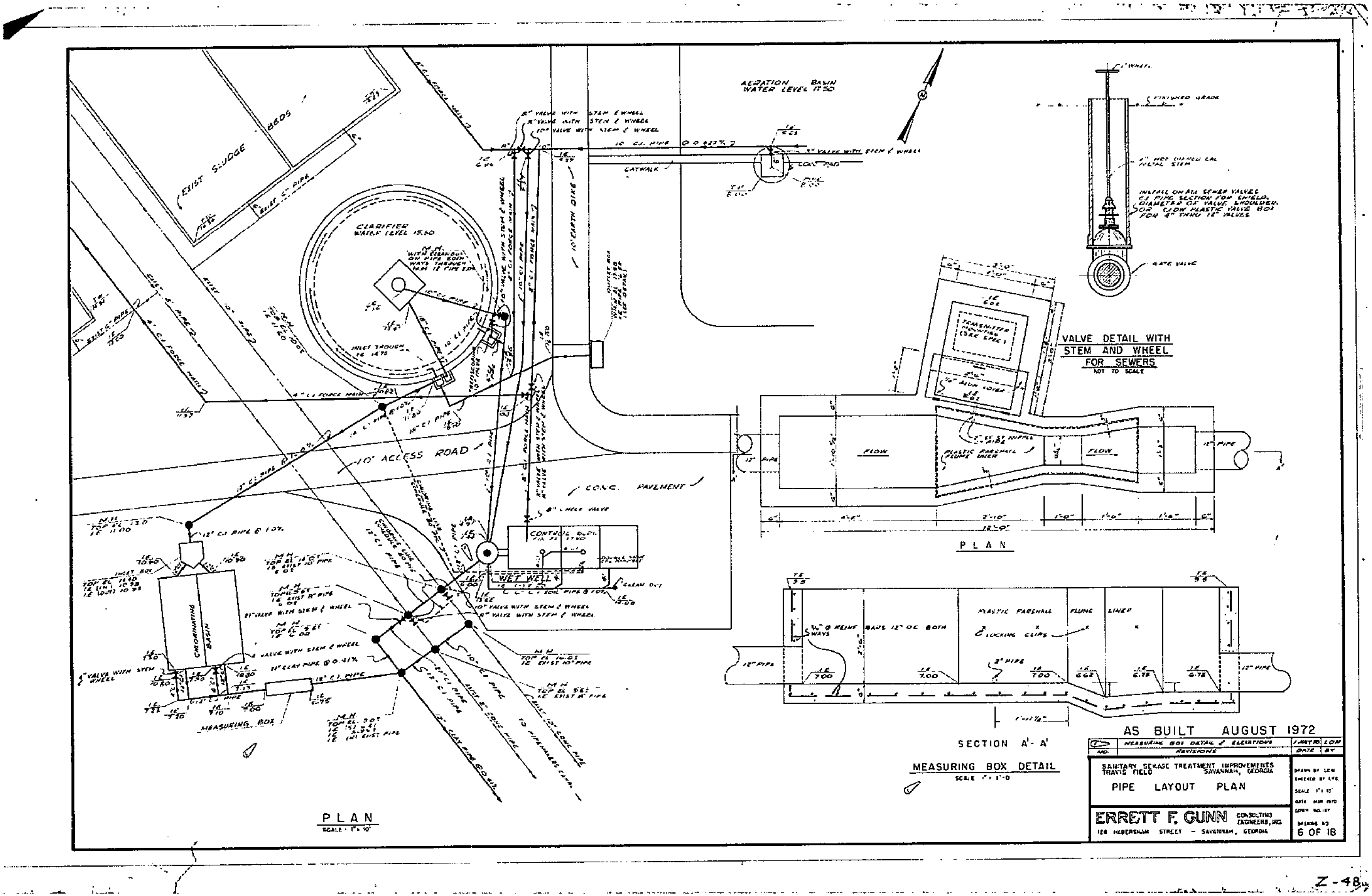
ERRETT F. GUNN CONSULTING ENGINEERS, INC.
128 HABERSHAM STREET — SAVANNAH, GEORGIA

12 OF 18

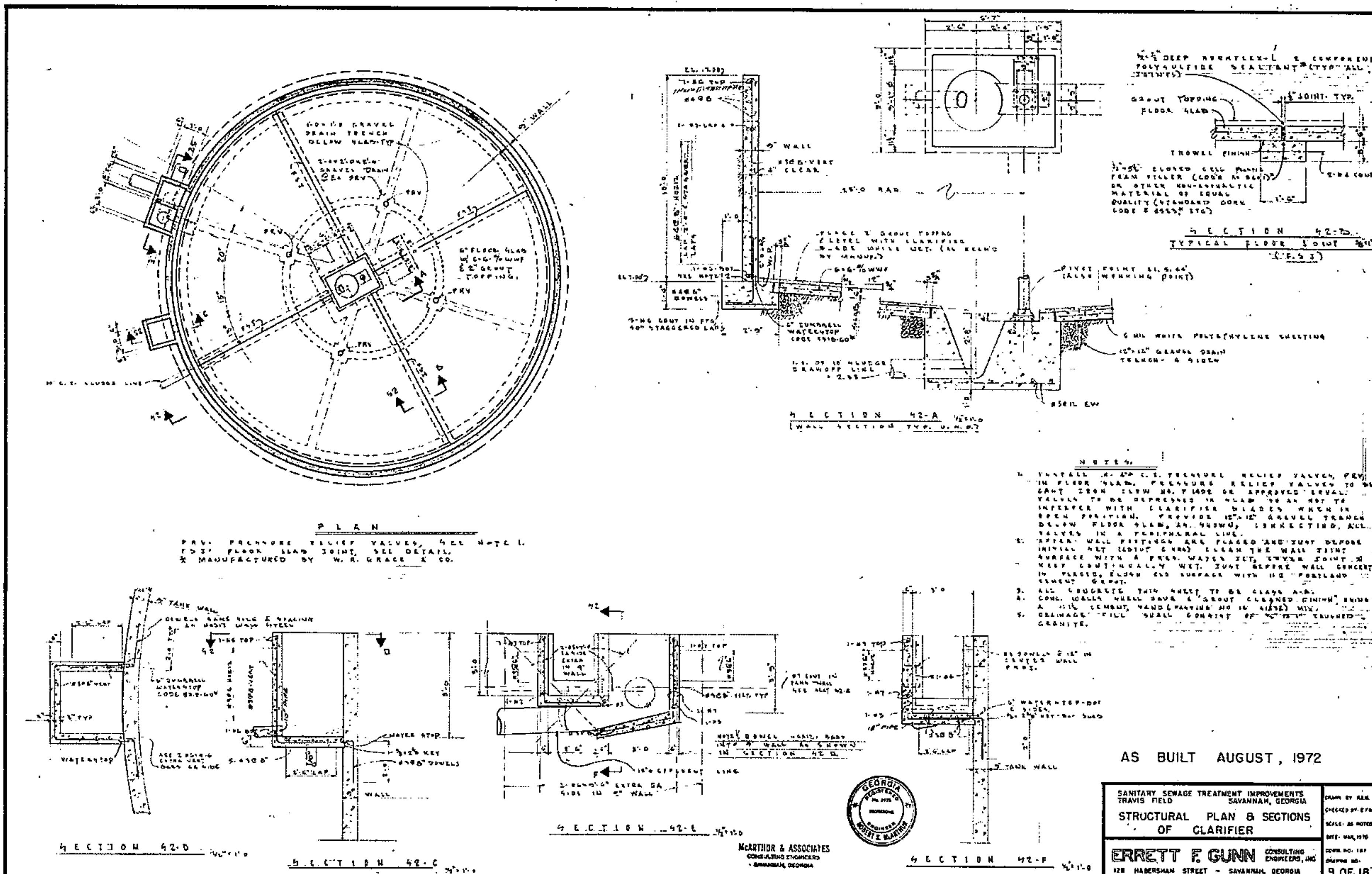
Z-42

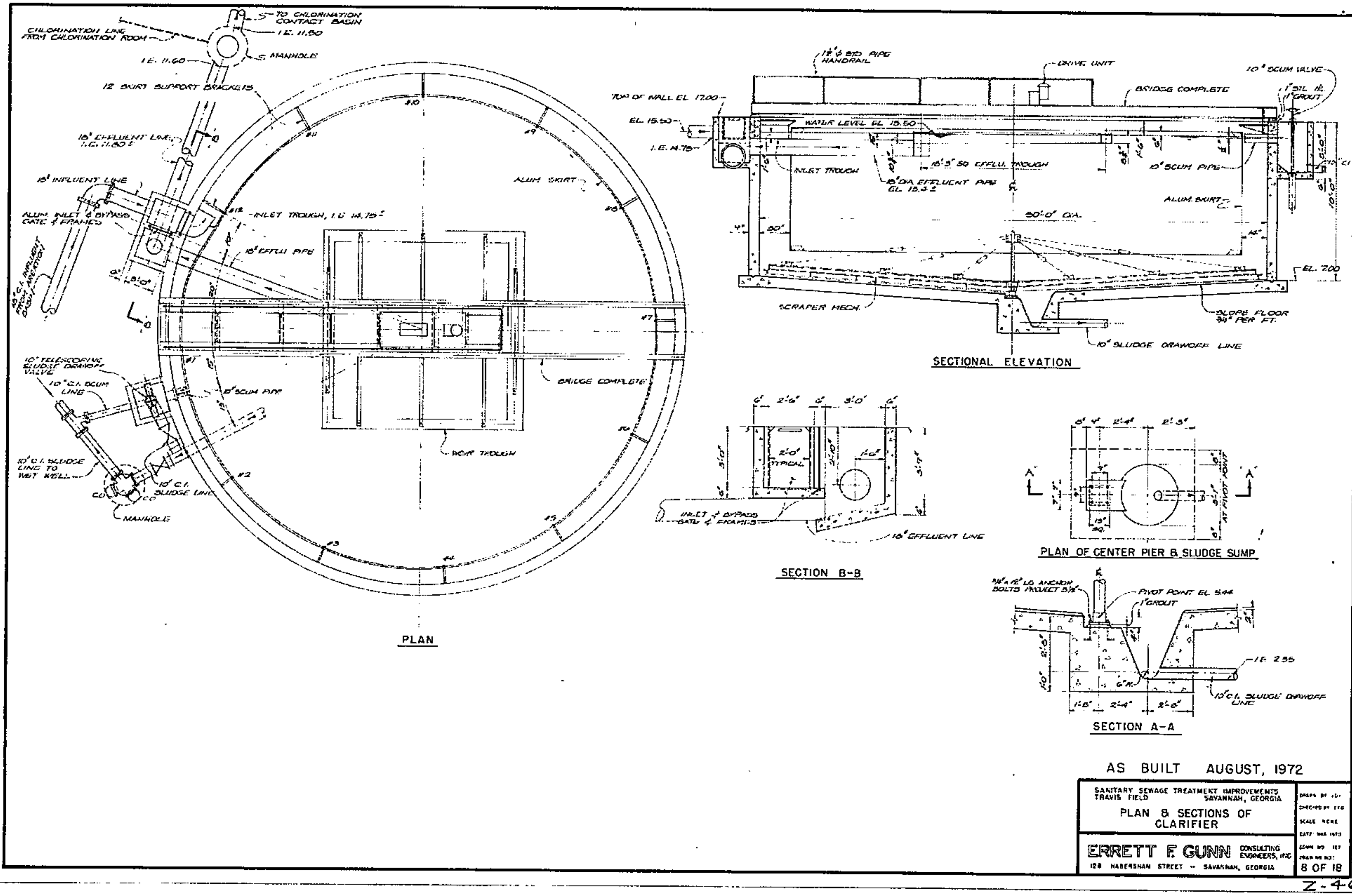


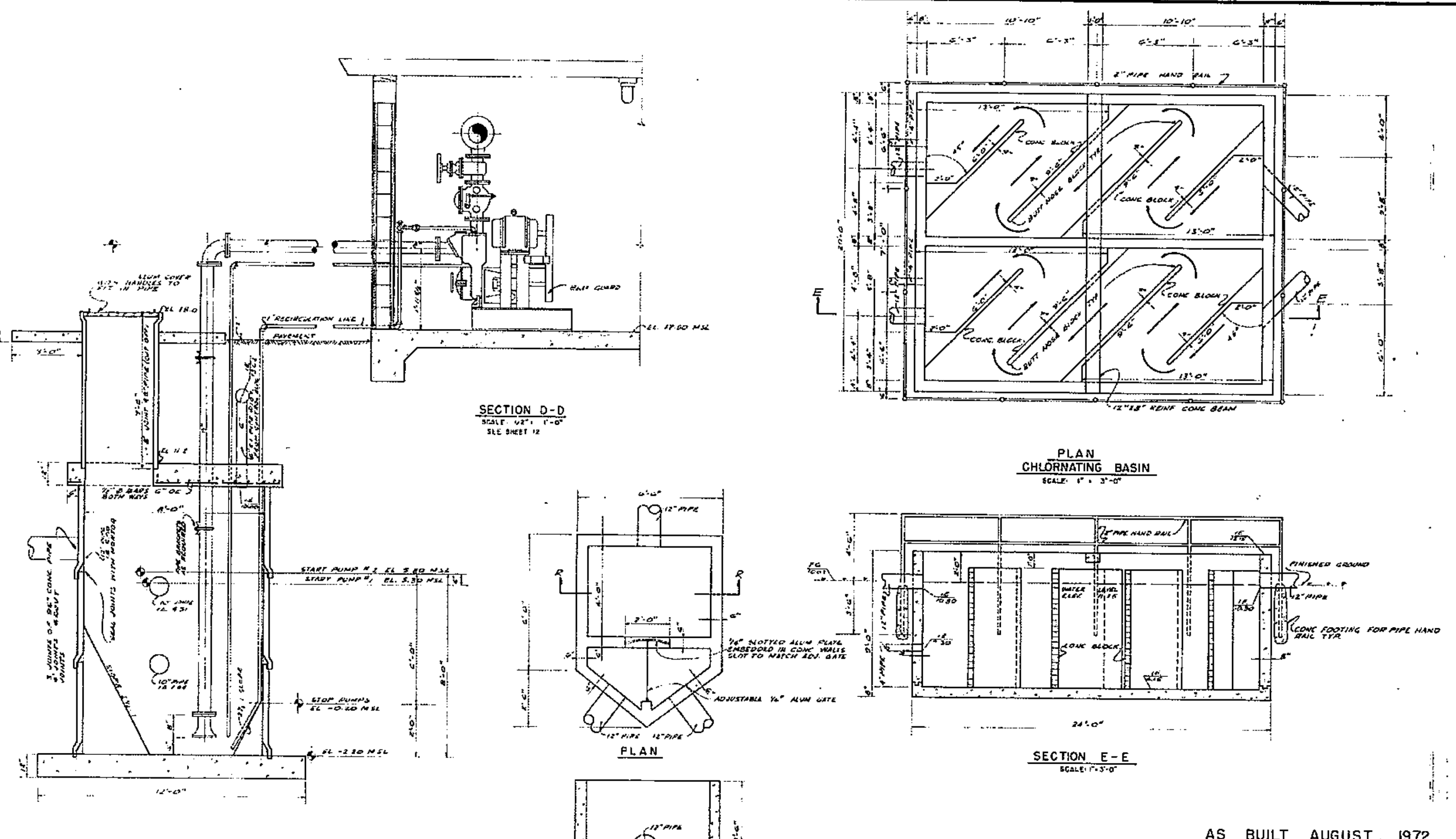
SECTION 41-B
PLAN
AERATOR PLATFORM AND CATWALK
SECTION 41-D
NOTES
SECTION 41-A
SECTION 41-C
AS BUILT AUGUST, 1972
SANITARY SEWAGE TREATMENT IMPROVEMENTS
TRAVIS FIELD
SAVANNAH, GEORGIA
PLAN & SECTION, AERATOR PLATFORM & CATWALK
ERRETT F. GUNN
128 HABERSHAM STREET
McARTHUR & ASSOCIATES
CONSULTING ENGINEERS
SAVANNAH, GEORGIA



AERATION BASIN WATER LEVEL 17.50
CLARIFIER WATER LEVEL 15.50
EXIST SLUDGE BEDS
10' EARTH DIKE
10' ACCESS ROAD
CONC. PAVEMENT
CATWALK
CONTROL BLDG.
WET WELL
CHLORINATING BASIN
MEASURING BOX
TO PIPEMAKERS CANAL
PLAN
SCALE: 1" = 10'
VALVE DETAIL WITH STEM AND WHEEL FOR SEWERS
NOT TO SCALE
GATE VALVE
FINISHED GRADE
FLOW
PLASTIC PARSHALL FLUME LINER
TRANSMITTER MOUNTING (SEE SPEC.)
PLAN
SECTION A'-A'
MEASURING BOX DETAIL
SCALE 1" = 1'-0
AS BUILT AUGUST 1972
MEASURING BOX DETAIL & ELEVATIONS
REVISIONS
NO.
DATE
BY
SANITARY SEWAGE TREATMENT IMPROVEMENTS TRAVIS FIELD SAVANNAH, GEORGIA
PIPE LAYOUT PLAN
ERRETT F. GUNN CONSULTING ENGINEERS, INC.
128 HABERSHAM STREET - SAVANNAH, GEORGIA
6 OF 18
Z-48


PLAN
PRV: PRESSURE RELIEF VALVES, SEE NOTE 1.
FSJ: FLOOR SLAB JOINT, SEE DETAIL.
* MANUFACTURED BY W. R. GRACE & CO.
9" WALL
SECTION 42-A
SECTION 42-B
TYPICAL FLOOR JOINT
SECTION 42-C
SECTION 42-D
SECTION 42-E
SECTION 42-F
NOTES
AS BUILT AUGUST, 1972
SANITARY SEWAGE TREATMENT IMPROVEMENTS
TRAVIS FIELD
SAVANNAH, GEORGIA
STRUCTURAL PLAN & SECTIONS OF CLARIFIER
ERRETT F. GUNN CONSULTING ENGINEERS, INC
128 HABERSHAM STREET - SAVANNAH, GEORGIA
McARTHUR & ASSOCIATES
CONSULTING ENGINEERS
SAVANNAH, GEORGIA
GEORGIA
9 OF 18
Z-45


PLAN
SECTIONAL ELEVATION
SECTION B-B
PLAN OF CENTER PIER & SLUDGE SUMP
SECTION A-A
TO CHLORINATION CONTACT BASIN
CHLORINATION LINE FROM CHLORINATION ROOM
MANHOLE
12 SKIRT SUPPORT BRACKETS
INFLUENT LINE
ALUM INLET & BYPASS GATE & FRAMES
INLET TROUGH
EFFLU PIPE
SCUM PIPE
ALUM SKIRT
BRIDGE COMPLETE
WEIR TROUGH
SLUDGE LINE
MANHOLE
HANDRAIL
DRIVE UNIT
SCUM VALVE
TOP OF WALL EL 17.00
WATER LEVEL EL 15.50
SQ EFFLU. TROUGH
50'-0" DIA.
SCRAPER MECH.
SLOPE FLOOR
SLUDGE DRAWOFF LINE
EL. 7.00
INLET & BYPASS GATE & FRAMES
EFFLUENT LINE
PIVOT POINT EL 5.44
GROUT
AS BUILT AUGUST, 1972
SANITARY SEWAGE TREATMENT IMPROVEMENTS
TRAVIS FIELD SAVANNAH, GEORGIA
PLAN & SECTIONS OF CLARIFIER
ERRETT F. GUNN CONSULTING ENGINEERS, INC
128 HABERSHAM STREET — SAVANNAH, GEORGIA
8 OF 18
Z-46



AS BUILT AUGUST, 1972

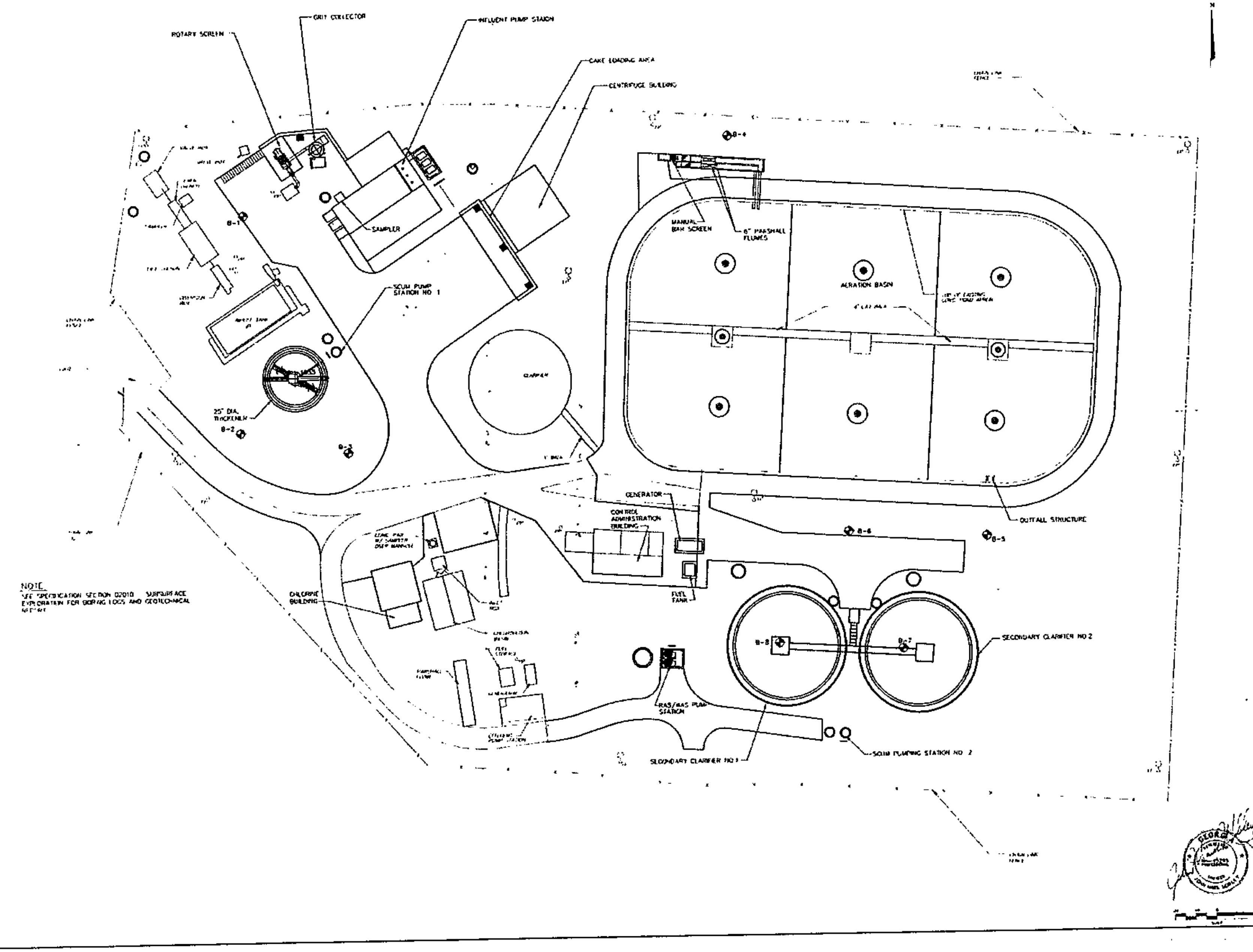
SANITARY SEWAGE TREATMENT IMPROVEMENTS
TRAVIS FIELD SAVANNAH, GEORGIA
PLAN & DETAILS OF CHLORINATING BASIN & SLUDGE LIFT STATION SECTIONS

ERRETT F. GUNN CONSULTING ENGINEERS, INC
128 HABERSHAM STREET - SAVANNAH, GEORGIA

15 OF 18

IZ-39

1996 Travis Field Expansion Plans
Set 1 Plans



NOTE
SEE SPECIFICATION SECTION 02010 SUBSURFACE EXPLORATION FOR BORING LOGS AND GEOTECHNICAL REPORT.

EMC ENGINEERING SERVICES, INC.
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23 East Charlton Street
Savannah, Georgia 31412
Phone (912) 232-6533

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY FOR THE CITY OF SAVANNAH

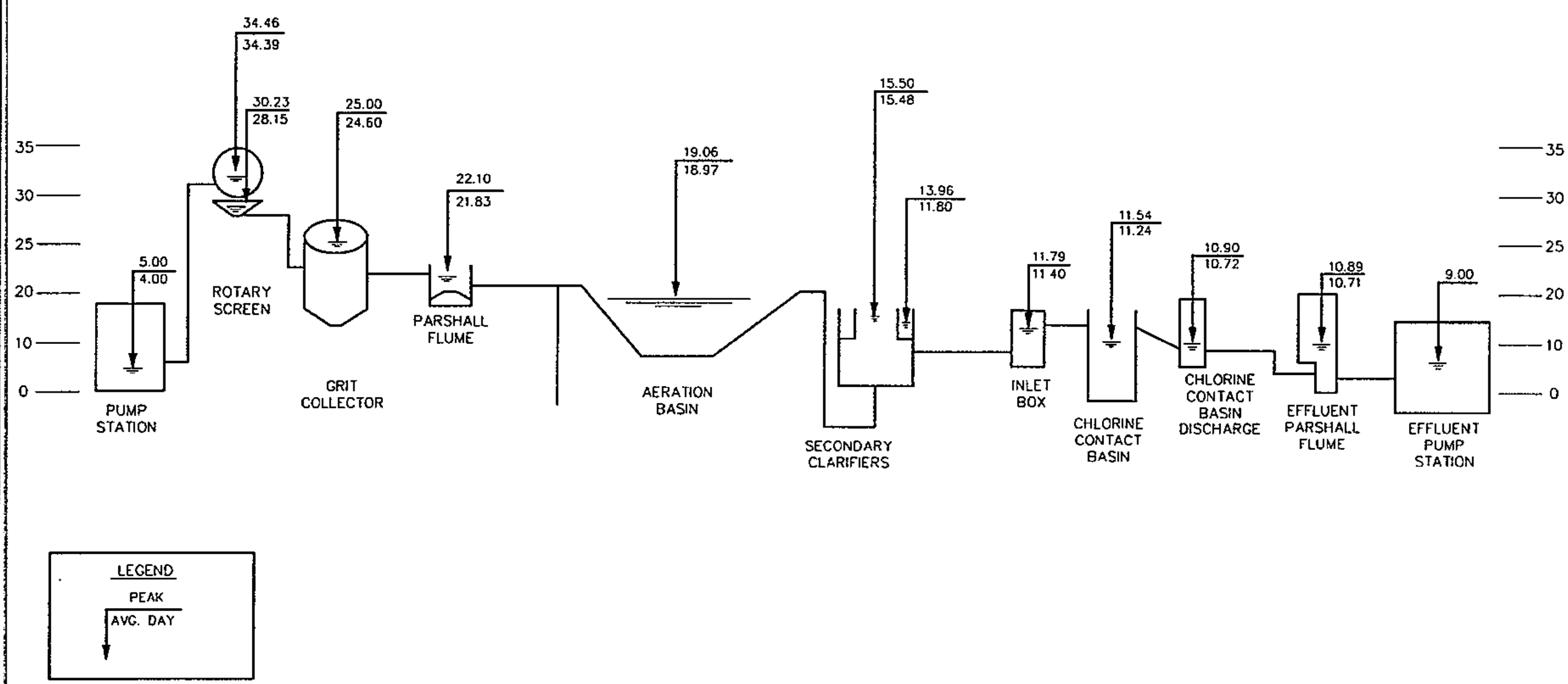
SITE PLAN & BORING LOCATIONS

REVISIONS	
NO.	DATE

DESIGN: EDI
GRAPHICS: MEH
REVIEW: BAM
DATE: AUGUST, 1996
SCALE: 1" = 20'
PROJECT: 93039

SHEET: G3 OF 41

AAAAA-60



HYDRAULIC PROFILE CONDITIONS			
FLOWS	MGD	GPM	CFS
PEAK HOUR	2.1	1458	3.2
AVERAGE DAY	1.5	1042	2.3

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Phone: (912) 232-6533

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY FOR THE CITY OF SAVANNAH

HYDRAULIC PROFILE

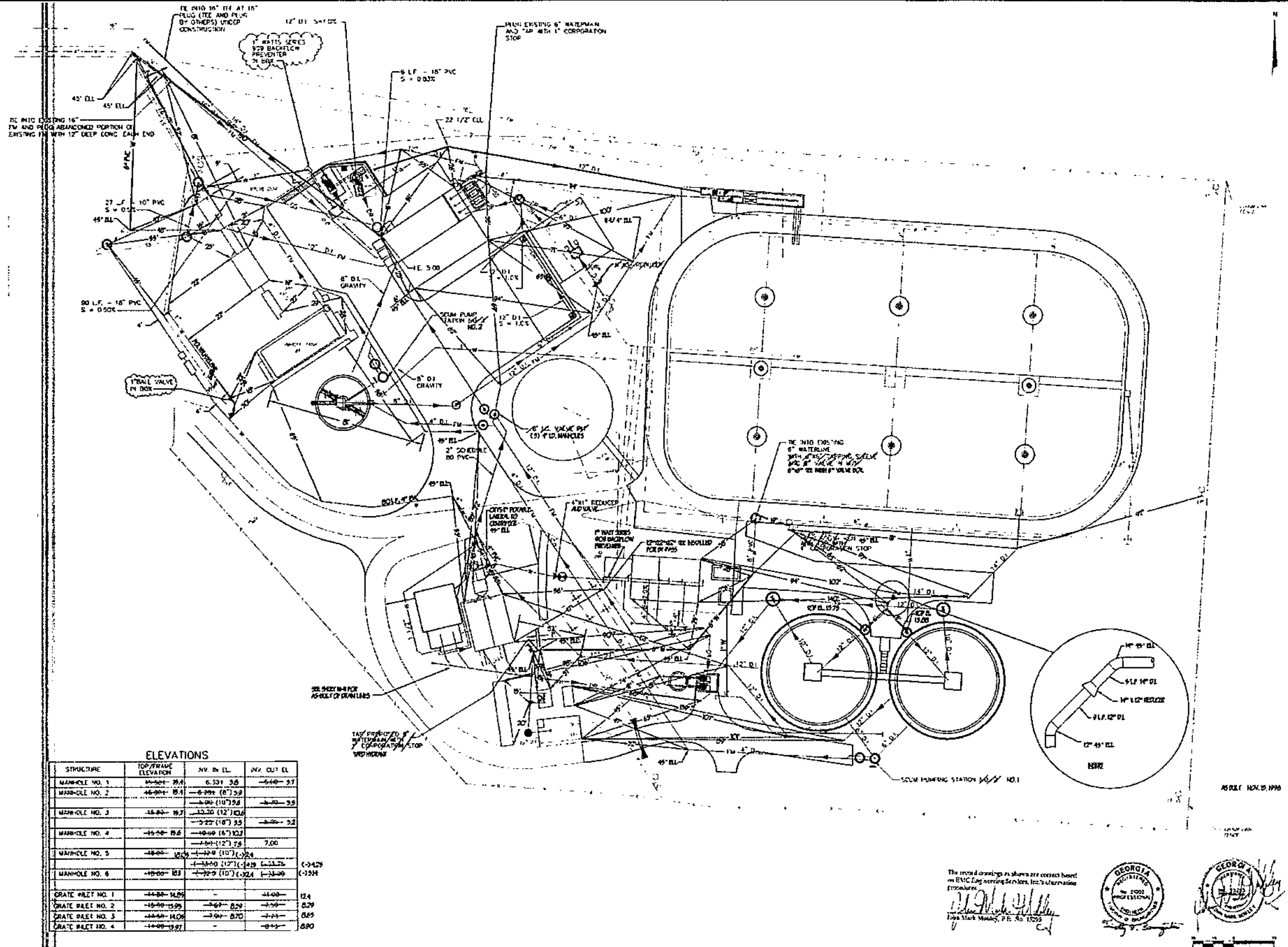
REVISIONS:

NO.	DATE

DESIGN: JMH
GRAPHICS: MEB
REVIEW: LMS
DATE: AUG. 1994
SCALE: NONE
PROJECT: 92039

SHEET: G4 OF 63

AAAAA-59



ELEVATIONS

STRUCTURE	TOP/FRAME ELEVATION	INV. IN EL.	INV. OUT EL.
MANHOLE NO. 1	~~15.50±~~ 15.4	6.30± 5.8	~~5.40~~ 5.7
MANHOLE NO. 2	~~16.00±~~ 15.4	~~6.29±~~ (8") 5.9	
		~~[illegible]~~ (10") 5.8	~~[illegible]~~ 5.5
MANHOLE NO. 3	~~16.80~~ 16.7	~~12.20~~ (12") 10.6	
		~~5.25~~ (18") 5.5	~~[illegible]~~ 5.2
MANHOLE NO. 4	~~16.50~~ 15.6	~~10.60~~ (6") 10.1	
		~~[illegible]~~ (12") 7.6	7.00
MANHOLE NO. 5	~~18.05~~ 18.05	~~(-)2.0~~ (10") (-)2.4	
		~~(-)3.50~~ (12") (-)4.19	~~(-)3.75~~ (-)4.25
MANHOLE NO. 6	~~18.00~~ 18.1	~~(-)2.9~~ (10") (-)2.4	~~(-)3.00~~ (-)3.34
GRATE INLET NO. 1	~~14.80~~ 14.05	-	~~11.00~~ 12.4
GRATE INLET NO. 2	~~15.90~~ 15.95	~~7.67~~ 8.29	~~7.50~~ 8.29
GRATE INLET NO. 3	~~14.50~~ 14.05	~~7.90~~ 8.70	~~7.71~~ 8.65
GRATE INLET NO. 4	~~14.00~~ 13.97	-	~~8.43~~ 8.90

The record drawings as shown are correct based on EMC Engineering Services, Inc.'s observation procedures.

John Mark Mosley, P.E. No. 15295

AS BUILT NOV. 15, 1996

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Phone: (912) 232-6533

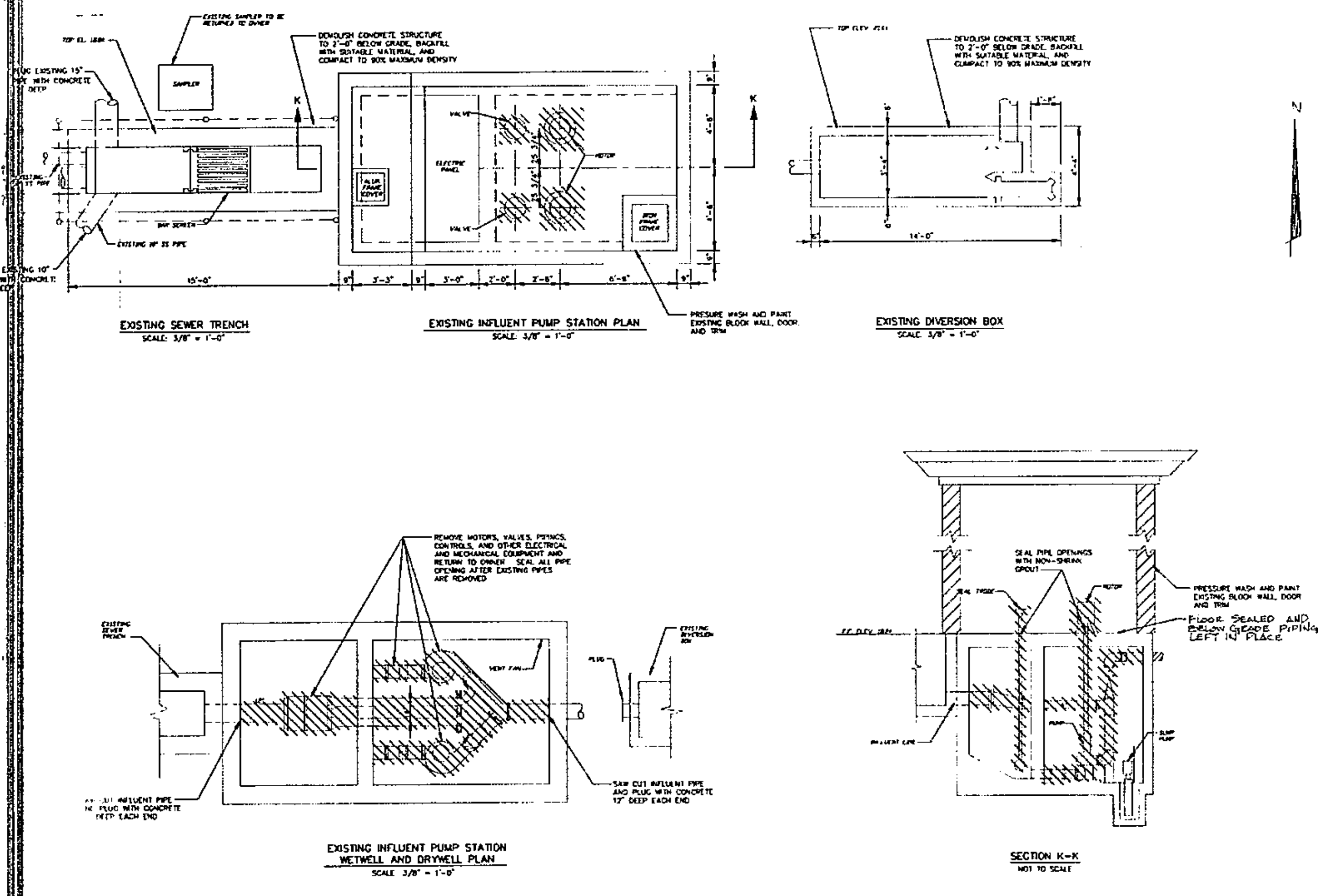
IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY FOR THE CITY OF SAVANNAH

SITE PIPING PLAN AS-BUILT

REVISIONS:	
1	9/27/94
2	10/28/94
3	4/19/95
4	5/15/95
5	6/30/95

DESIGN:	EGH
GRAPHICS:	MHB
REVIEW:	JWV
DATE:	AUGUST, 1994
SCALE:	1" = 20'
PROJECT:	92731
SHEET:	M1 OF 67

AA AAA-31A



NOTES:

1. ALL MECHANICAL AND ELECTRICAL EQUIPMENT, PIPING AND VALVES NOT INCORPORATED INTO THE NEW WORK SHALL BE REMOVED AND RETURNED TO OWNER
2. SEE THE ELECTRICAL PLAN FOR PROPOSED ELECTRICAL EQUIPMENT TO BE INSTALLED IN THE EXISTING PUMP STATION

The record drawings as shown are correct based on EMC Engineering Services, Inc.'s observation procedures.

John Mark Mobley P.E. No. 15753

EMC ENGINEERING SERVICES, INC
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone (912) 232-6533

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY FOR THE CITY OF SAVANNAH

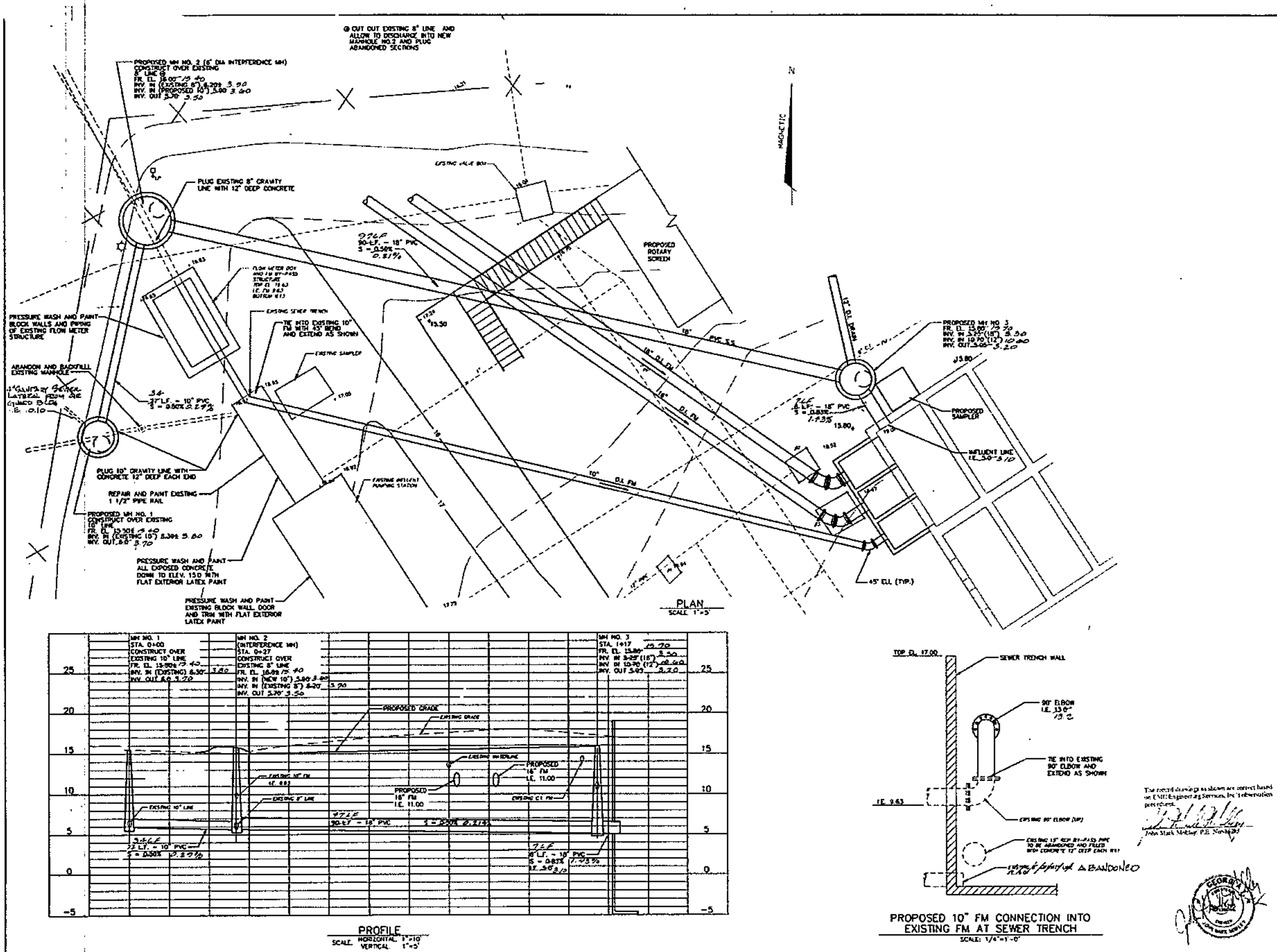
SEWER TRENCH, INFLUENT PUMP STATION, AND DIVERSION BOX DEMOLITION/IMPROVEMENT PLAN

REVISIONS	
NO.	DATE
AS-BUILT	11-18-96

DESIGN	EGH
GRAPHICS	MEB
REVIEW	JMM
DATE	AUG. 1994
SCALE	AS SHOWN
PROJECT	92019

SHEET C2 OF 83

AAAAA-54



EMC ENGINEERING SERVICES, INC.
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone: (912) 232-6533

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY FOR THE CITY OF SAVANNAH

INFLUENT SEWERLINES PLAN AND PROFILE

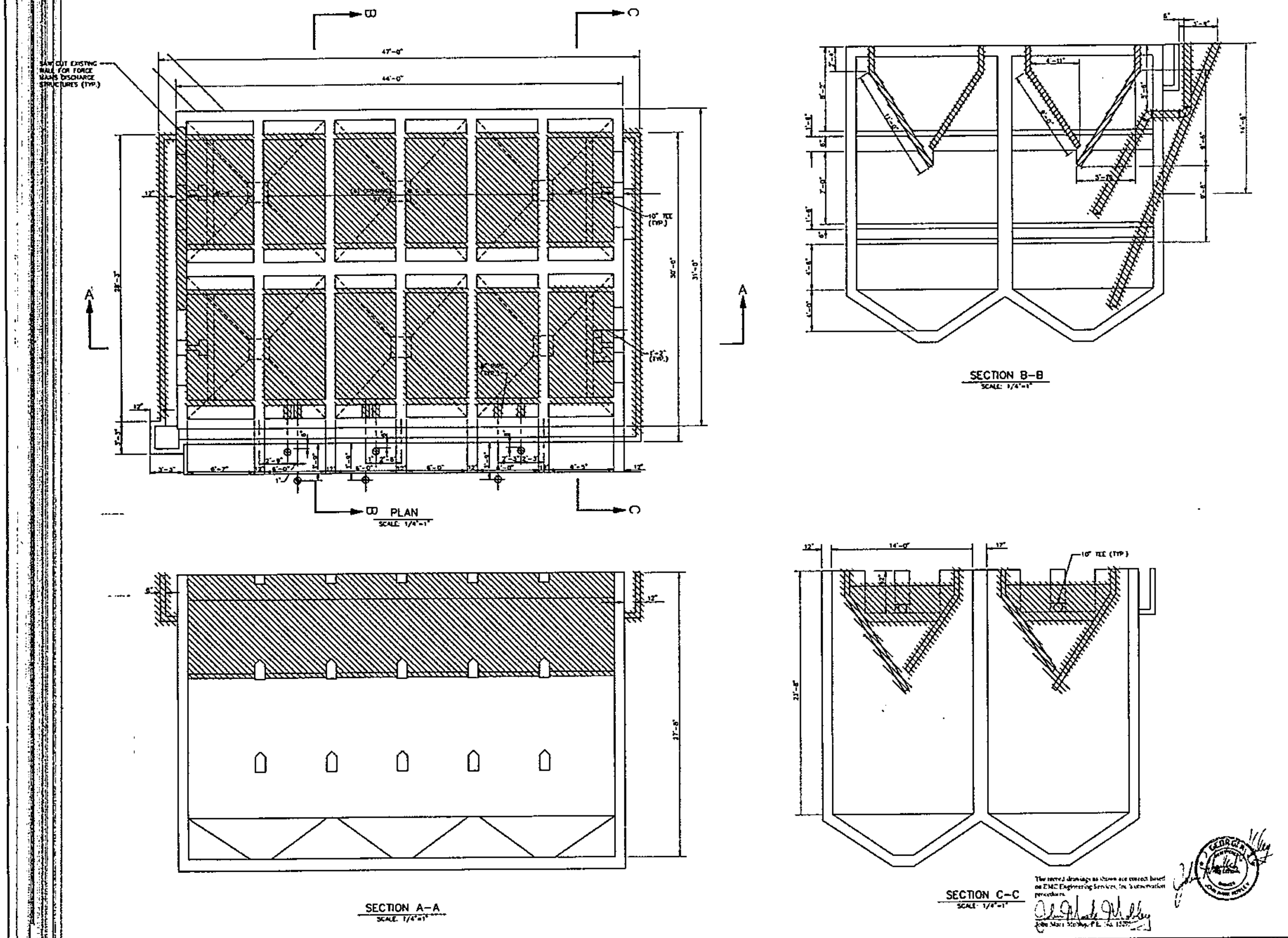
The record drawings as shown are correct based on EMC Engineering Services, Inc.'s information procedures.

John Mack McKay P.E.

REVISIONS:	
NO.	DATE
AS BLT	11-15-95

DESIGN:	EGH
GRAPHICS:	MEB
REVIEW:	JMM
DATE:	AUG., 1994
SCALE:	AS SHOWN
PROJECT:	92033
SHEET:	C10 OF 63

AAAAA-46



The record drawings as shown are correct based on EMC Engineering Services, Inc.'s observation procedures.

John Marc Motley, P.E.

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

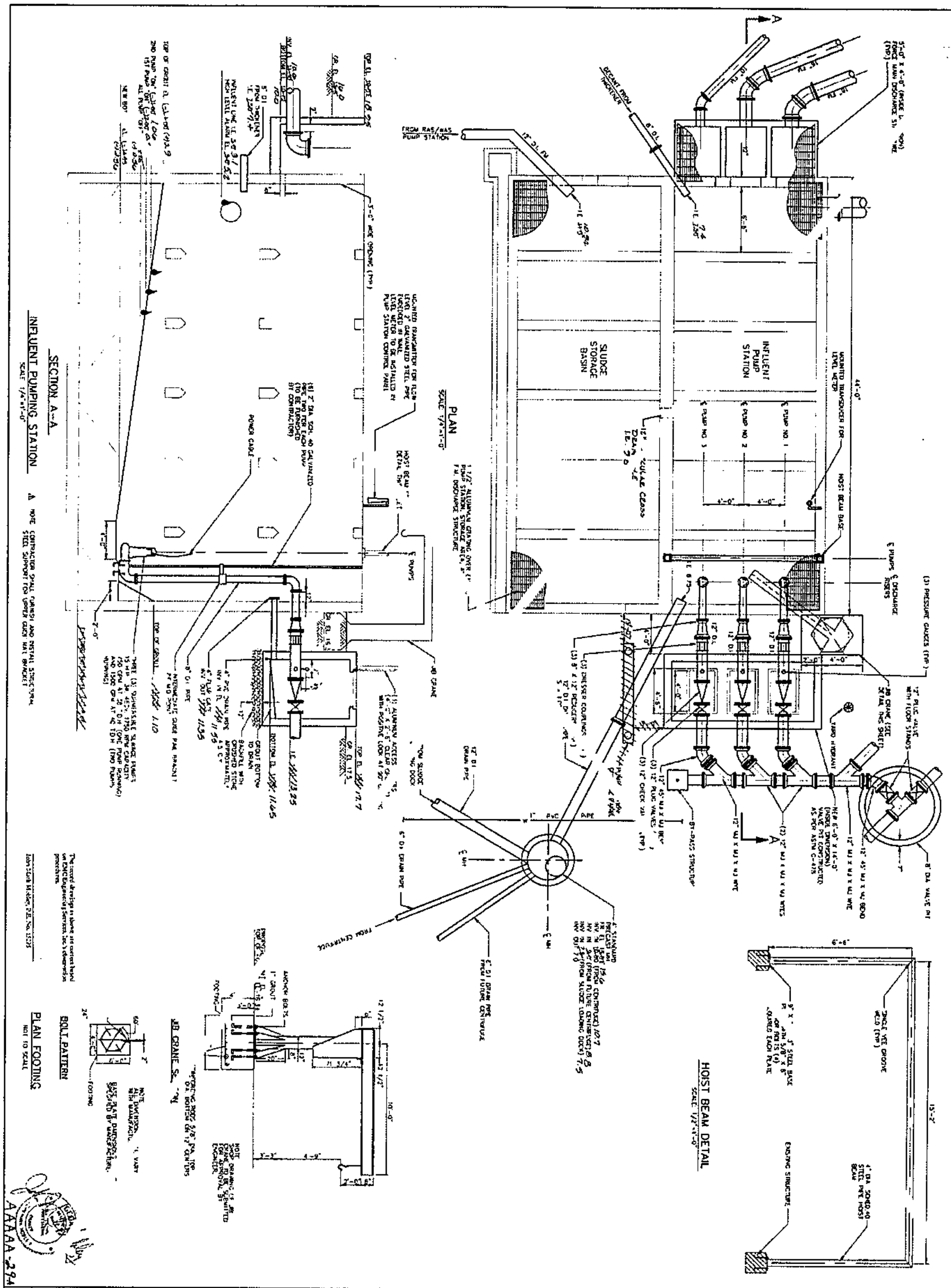
IMHOFF TANK NO. 2 DEMOLITION PLAN

EMC ENGINEERING SERVICES, INC.
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone: (912) 232-6533

REVISIONS	
NO	DATE
AS BUILT	10-18-95

DESIGN: EGH
GRAPHICS: MCB
REVIEW: JHH
DATE: MARCH, 1993
SCALE: AS SHOWN
PROJECT: 92039
SHEET: C4 OF 63

AAAAA 52



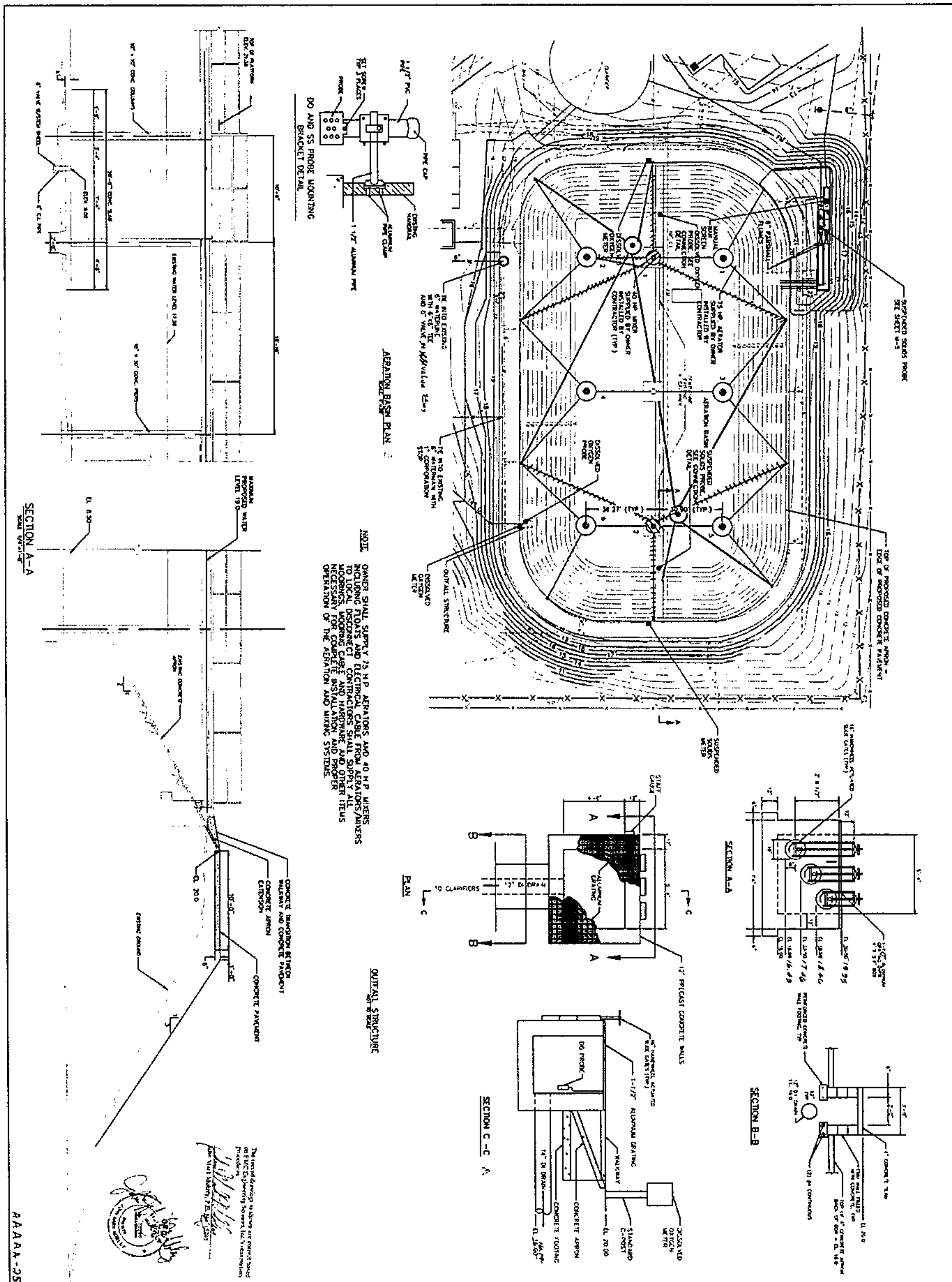
INFLUENT PUMP STATION
PLAN AND SECTIONS

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING
SERVICES INC.

Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone (912) 232-6533

SHEET M2 OF 63



AERATION BASIN PLAN, SECTIONS AND DETAILS

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING SERVICES, INC.

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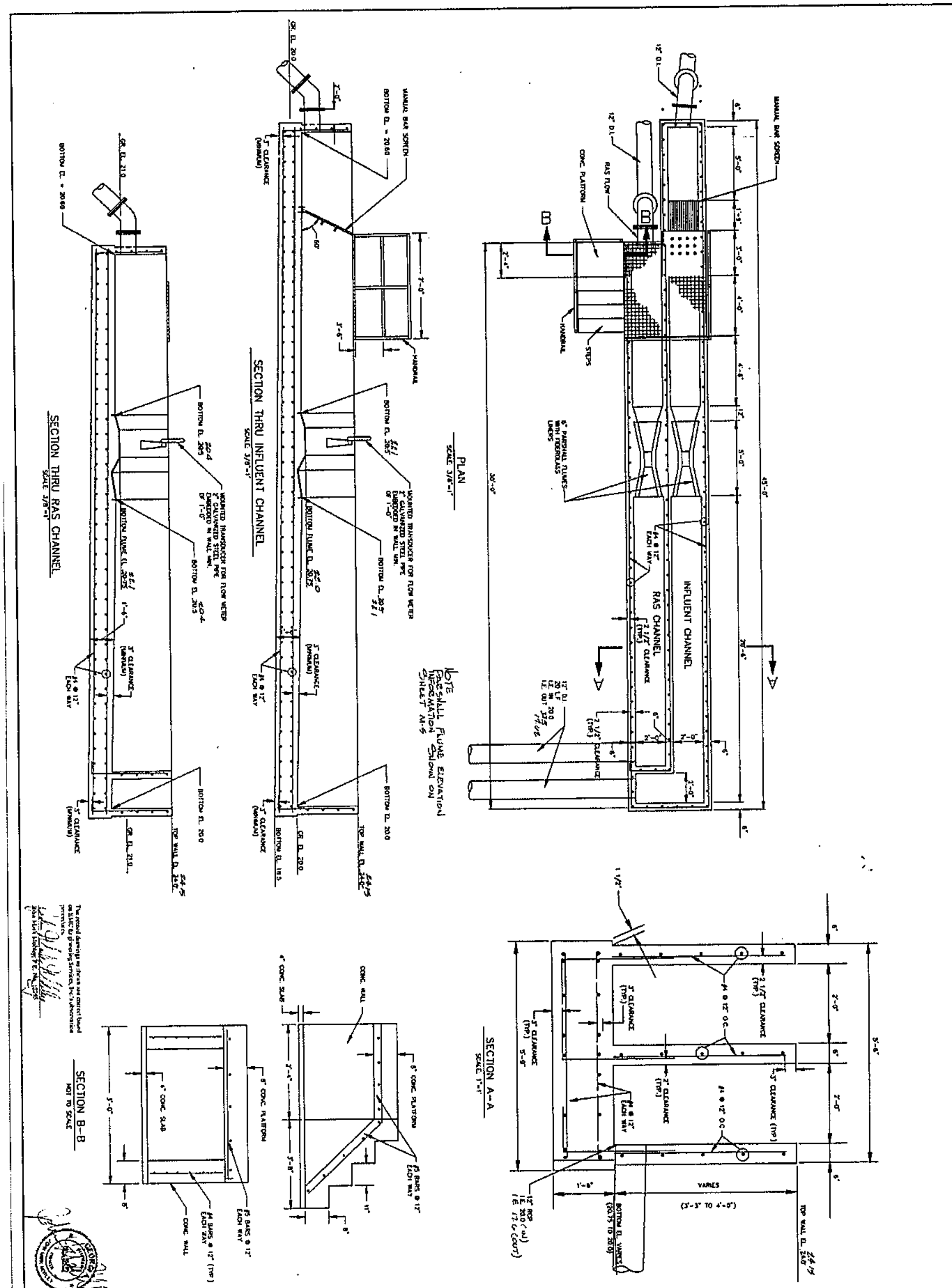
Phone: (912) 232-6533

SHEET M6 OF 64



PARSHALL FLUMES
PLAN AND SECTIONS

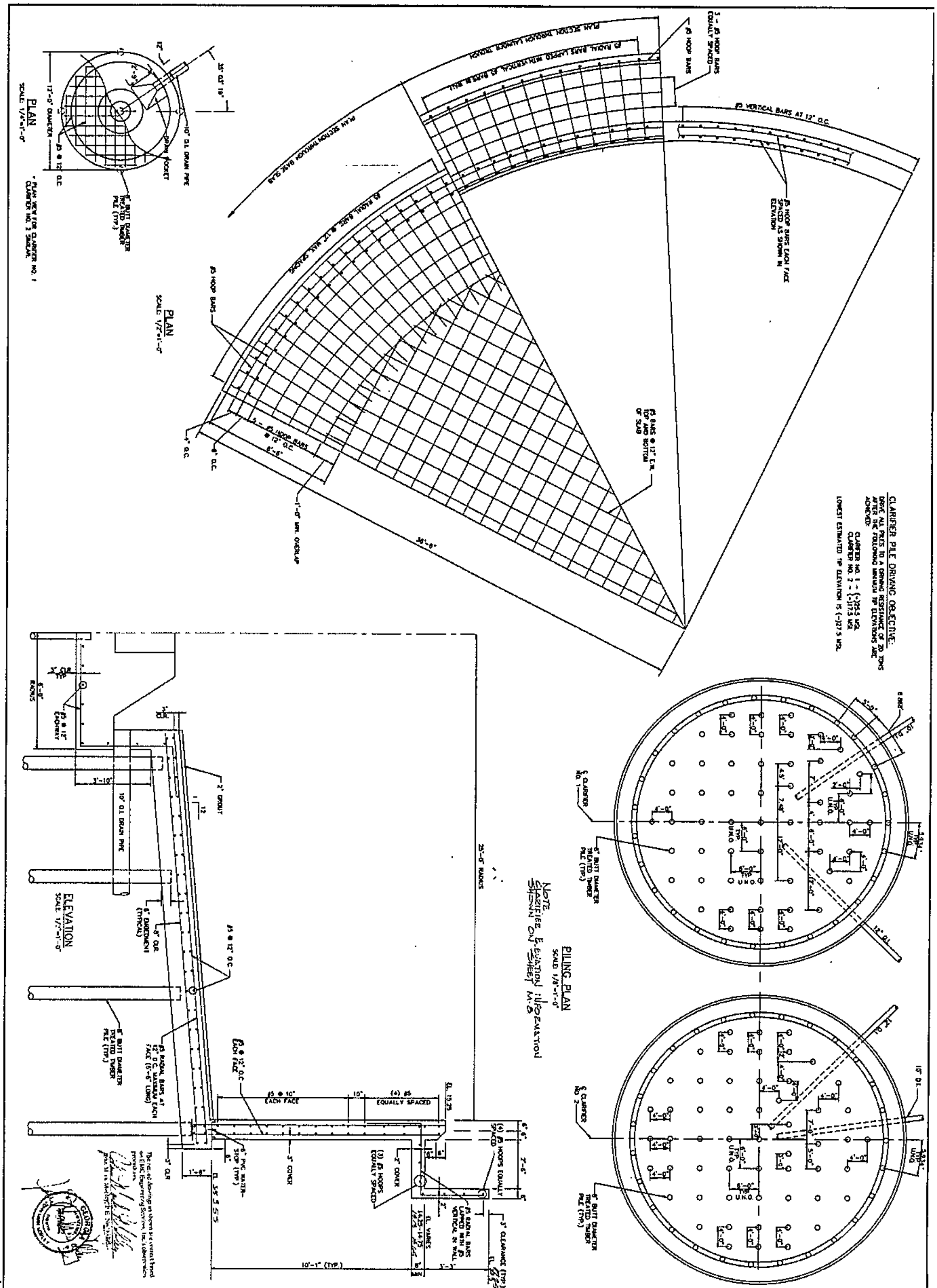
IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING SERVICES, INC.

Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone: (912) 232-6533

SHEET S3

1996 Travis Field Expansion Plans
Set 2 Plans



CLARIFIER PLAN AND SECTIONS

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

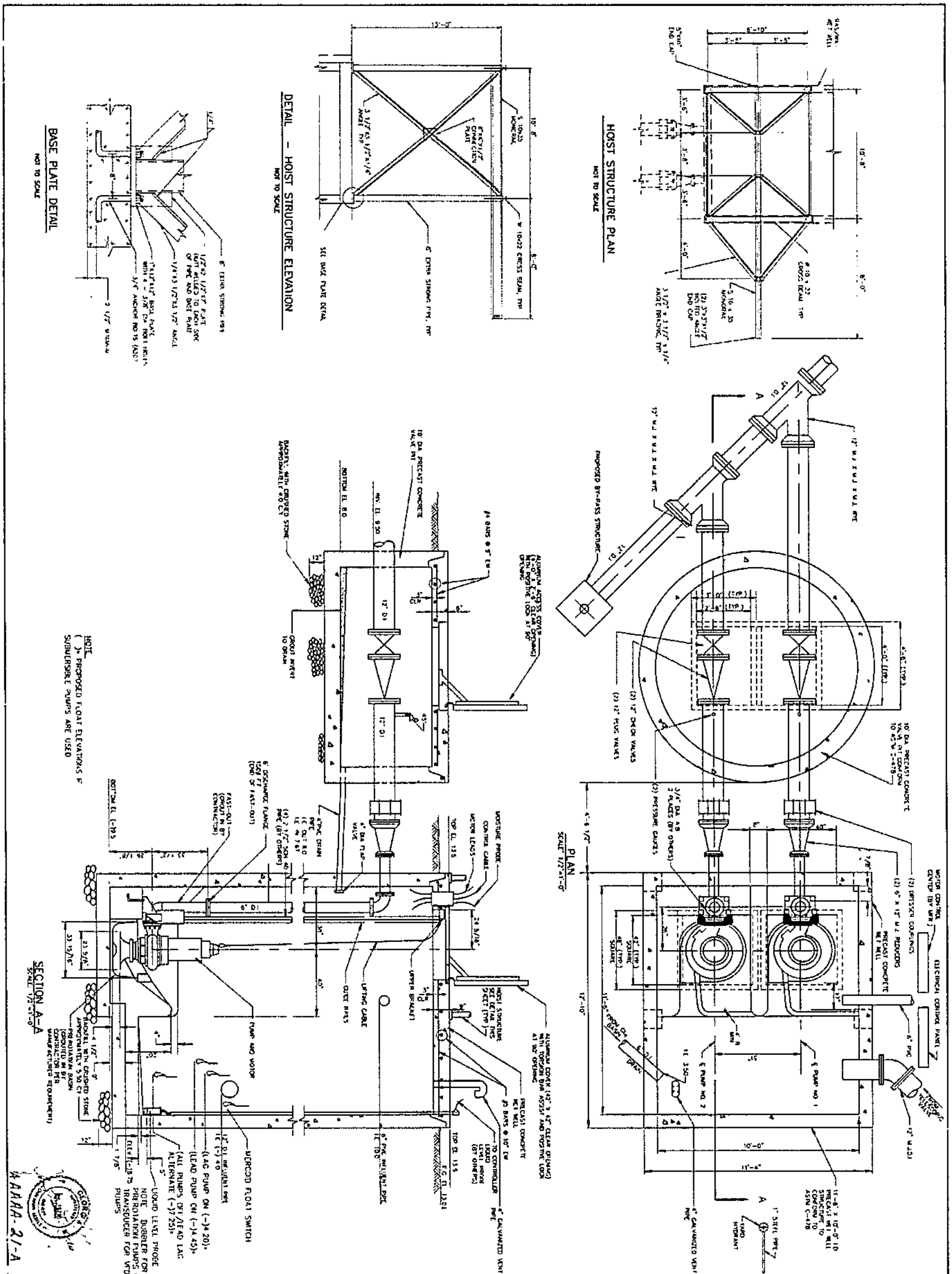
EMC ENGINEERING SERVICES, INC.
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone: (912) 232-6533

REVISIONS	
NO.	DATE
As Built	11-12-96

DESIGN	MBI
GRAPHICS	MEB
REVIEW	JWH
DATE	AUGUST, 1994
SCALE	AS SHOWN
PROJECT	92039

SHEET S4 OF 63

AAAA-36



RAS/WAS PUMP STATION
PLAN, SECTION & DETAILS

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING
SERVICES, INC

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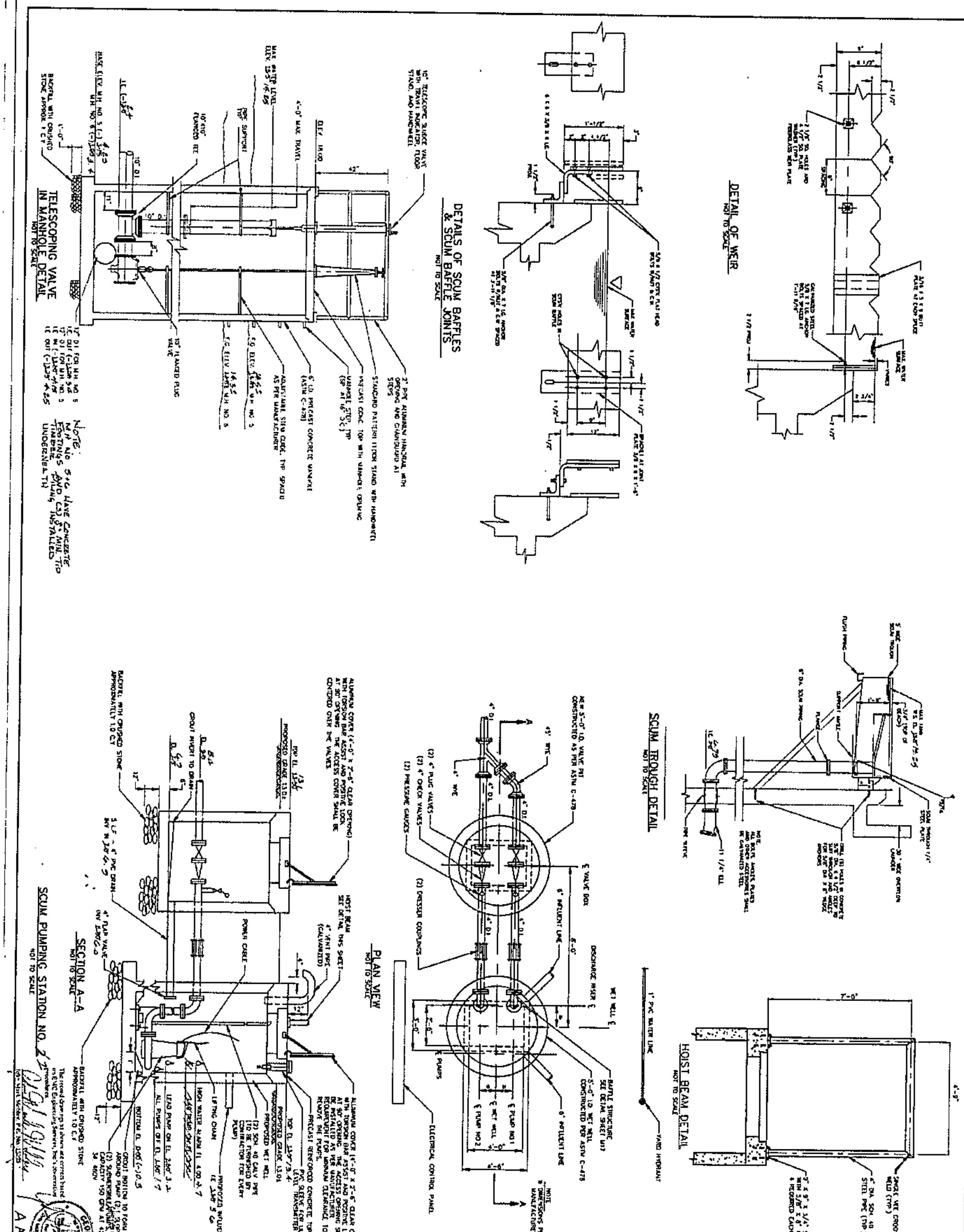
23 East Charlton Street
Savannah, Georgia 31412
Phone: (912) 232-6533

SHEET M10 OF 83



EMC ENGINEERING SERVICES, INC.

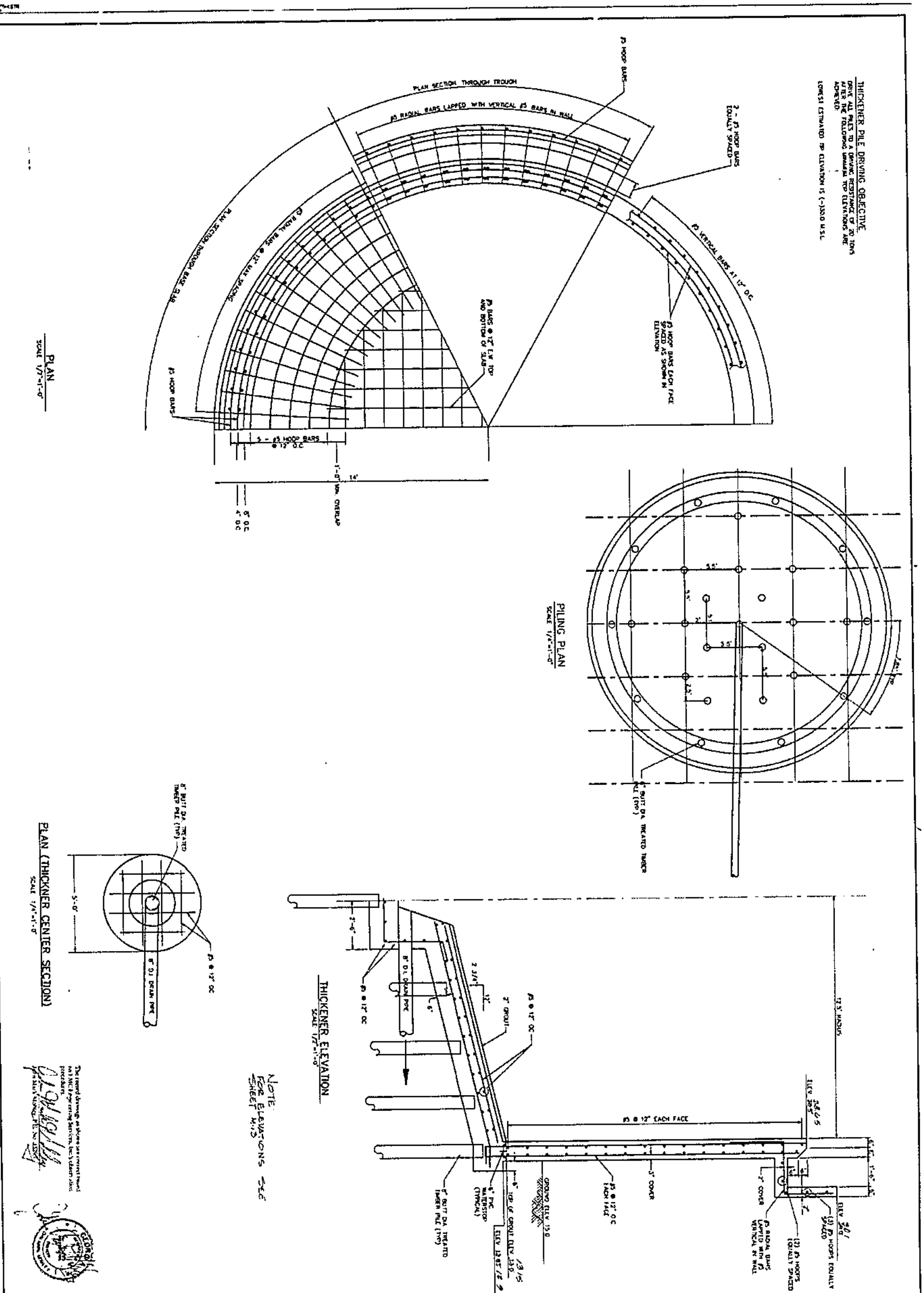
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone: (912) 232-6533

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY FOR THE CITY OF SAVANNAH

CLARIFIER SECTIONS & DETAILS

REVISIONS:	
NO.	DATE

DESIGN:	EGH
GRAPHICS:	MEB
REVIEW:	JAH
DATE:	AUG. 1994
SCALE:	AS SHOWN
PROJECT:	92039
SHEET:	M9 OF 63



REVISIONS		
NO.	DATE	
...	...	

DESIGN
GRAPHICS
REVIEW
DATE
SCALE AS SHOWN
PROJECT

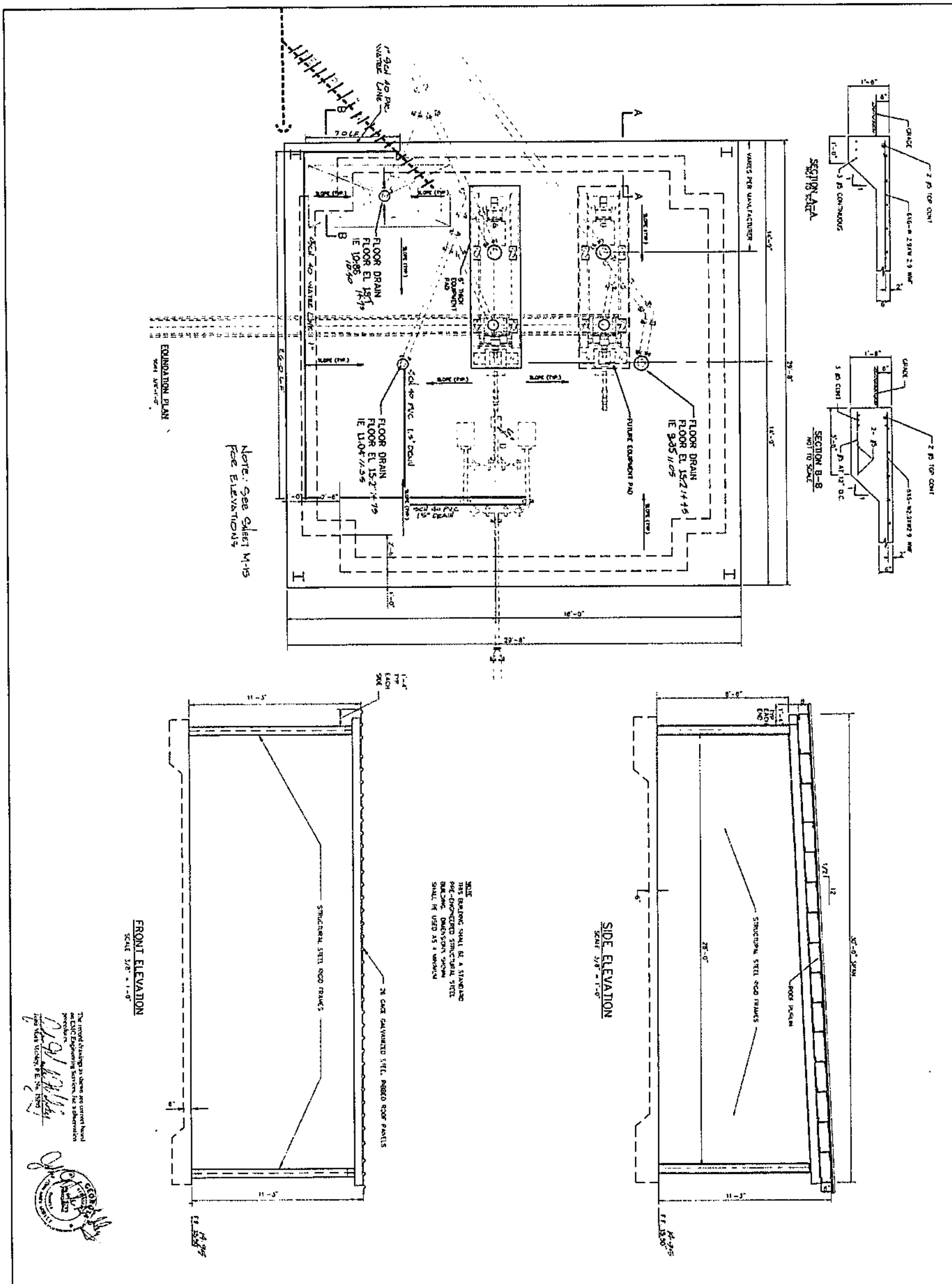
SHEET S6

SLUDGE THICKENER
PLAN AND SECTIONS

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING
SERVICES, INC.
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone (912) 232-6533

AAAAA-34



DESIGN	JWM
GRAPHICS	JDM
REVIEW	LMS
DATE	AUGUST 1996
SCALE	AS SHOWN
PROJECT	92035
SHEET	A5 OF 83

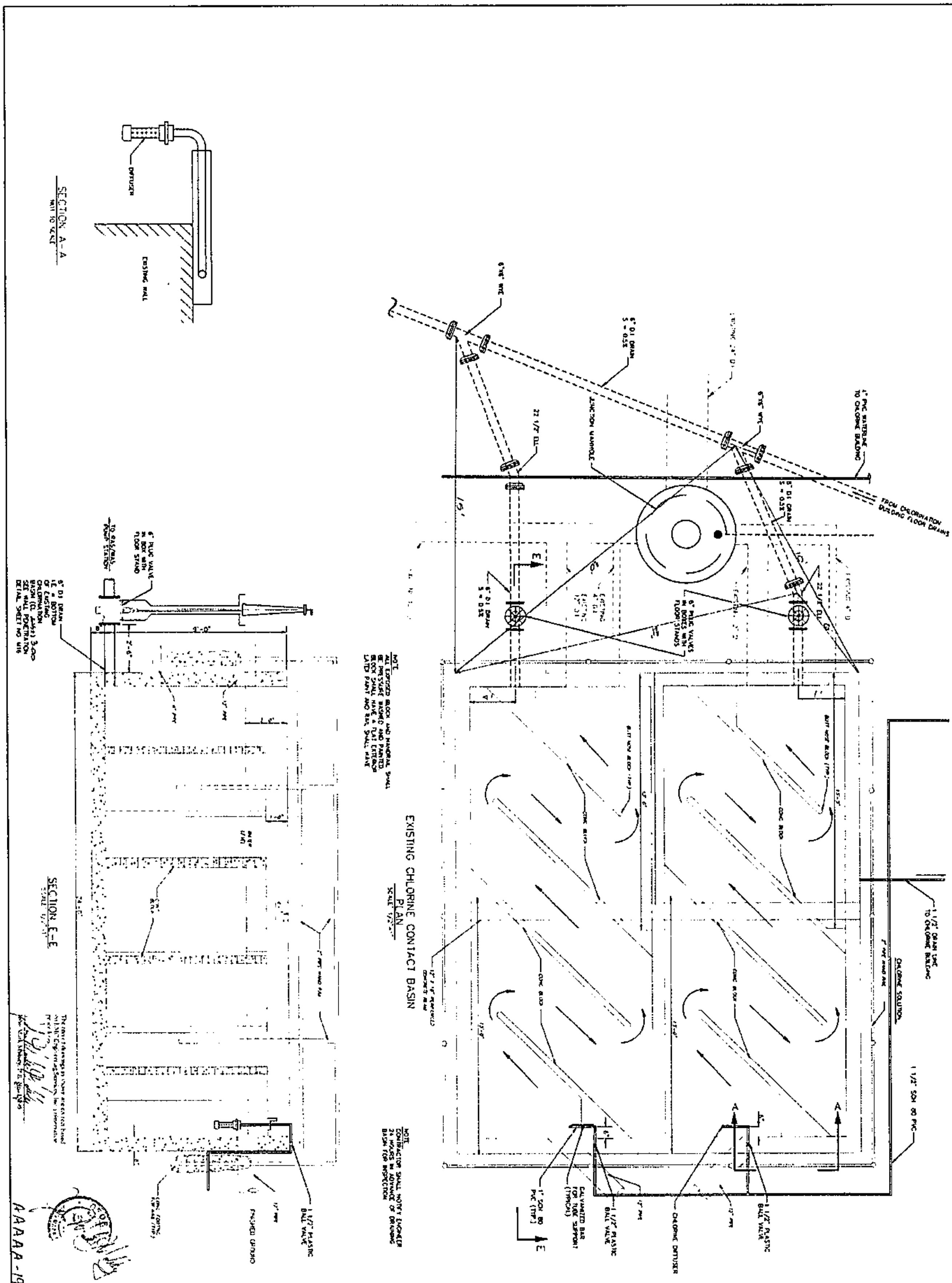
REVISIONS

CENTRIFUGE BUILDING
PLAN AND ELEVATIONS

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING SERVICES, INC.
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone (912) 232-6533

AAAAA-40



EMC ENGINEERING SERVICES, INC.	Post Office Box 8101 23 East Charlton Street Savannah, Georgia 31412 Phone (912) 232-6533

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY

FOR THE

CITY OF SAVANNAH

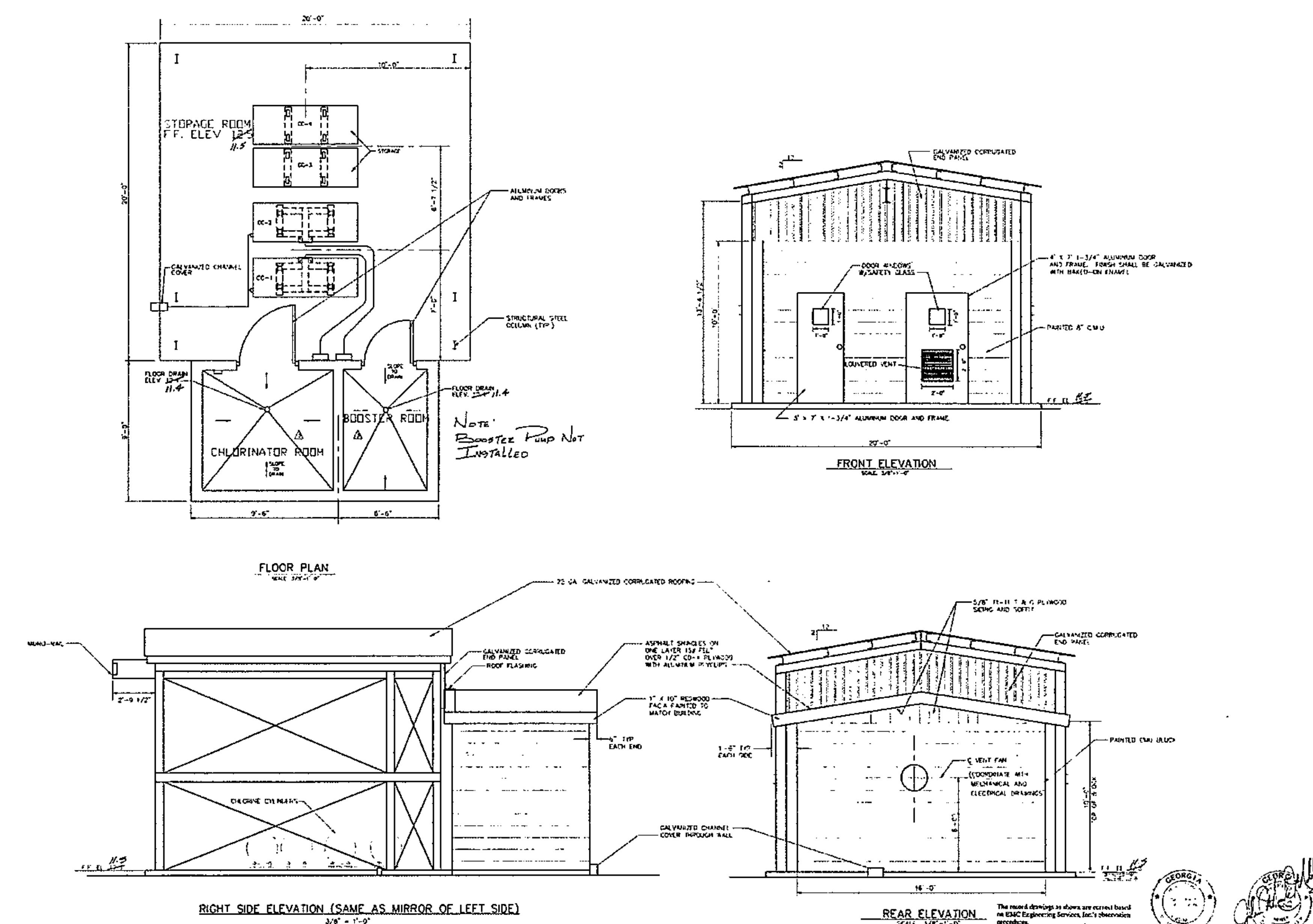
CHLORINATION SYSTEM PLAN AND SECTION

REVISIONS

NO.	DATE

DESIGN	JHW
GRAPHICS	WCD
REVIEW	JHW
DATE	AUGUST, 1994
SCALE	AS SHOWN
PROJECT	92039

SHEET M12 OF 83



The record drawings as shown are correct based on EMC Engineering Services, Inc.'s observation procedures.

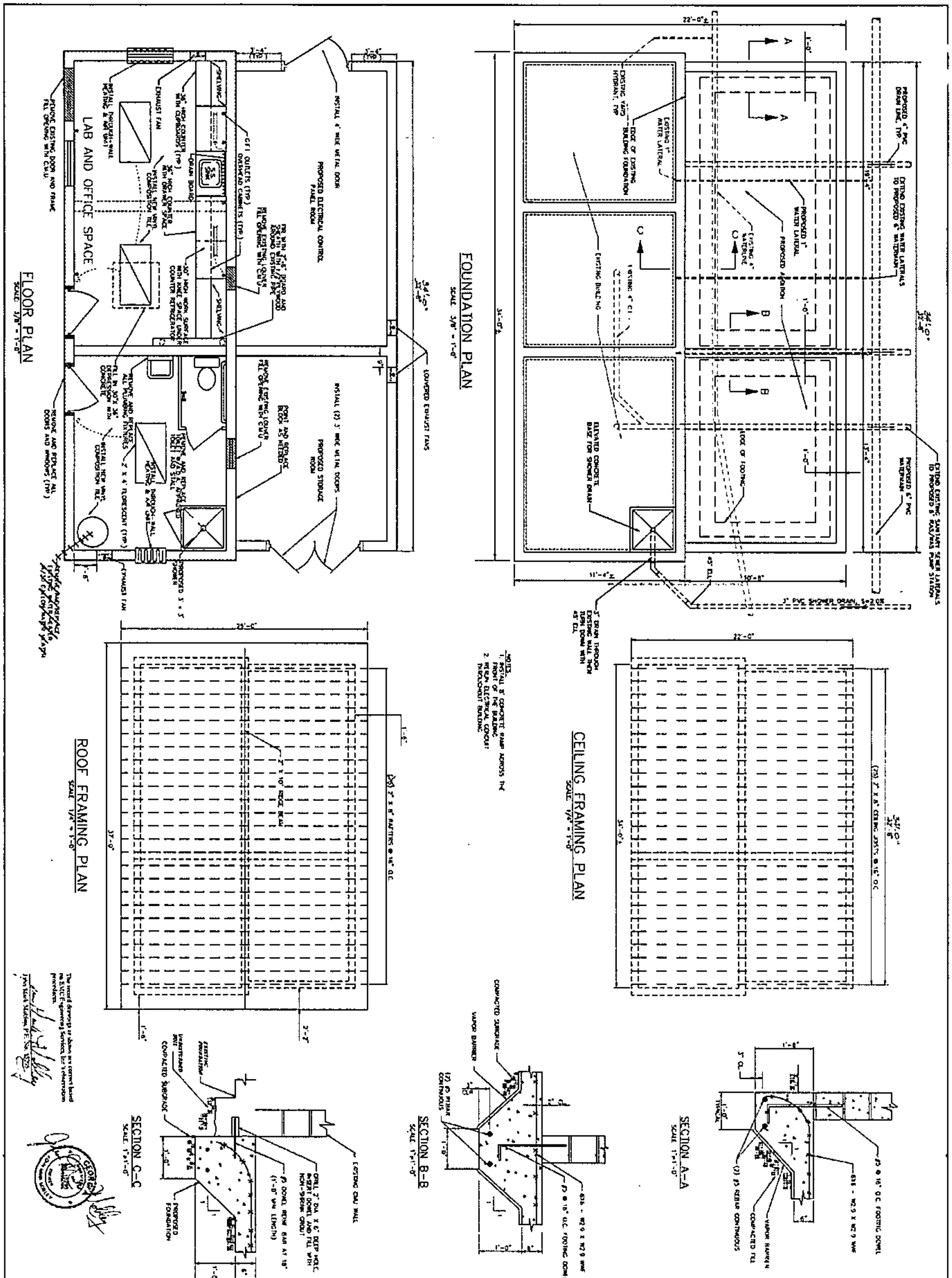
John Mark Mobley, P.E. No. 15087

CHLORINE BUILDING
PLAN AND ELEVATIONS

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

A3

AAAAA-42



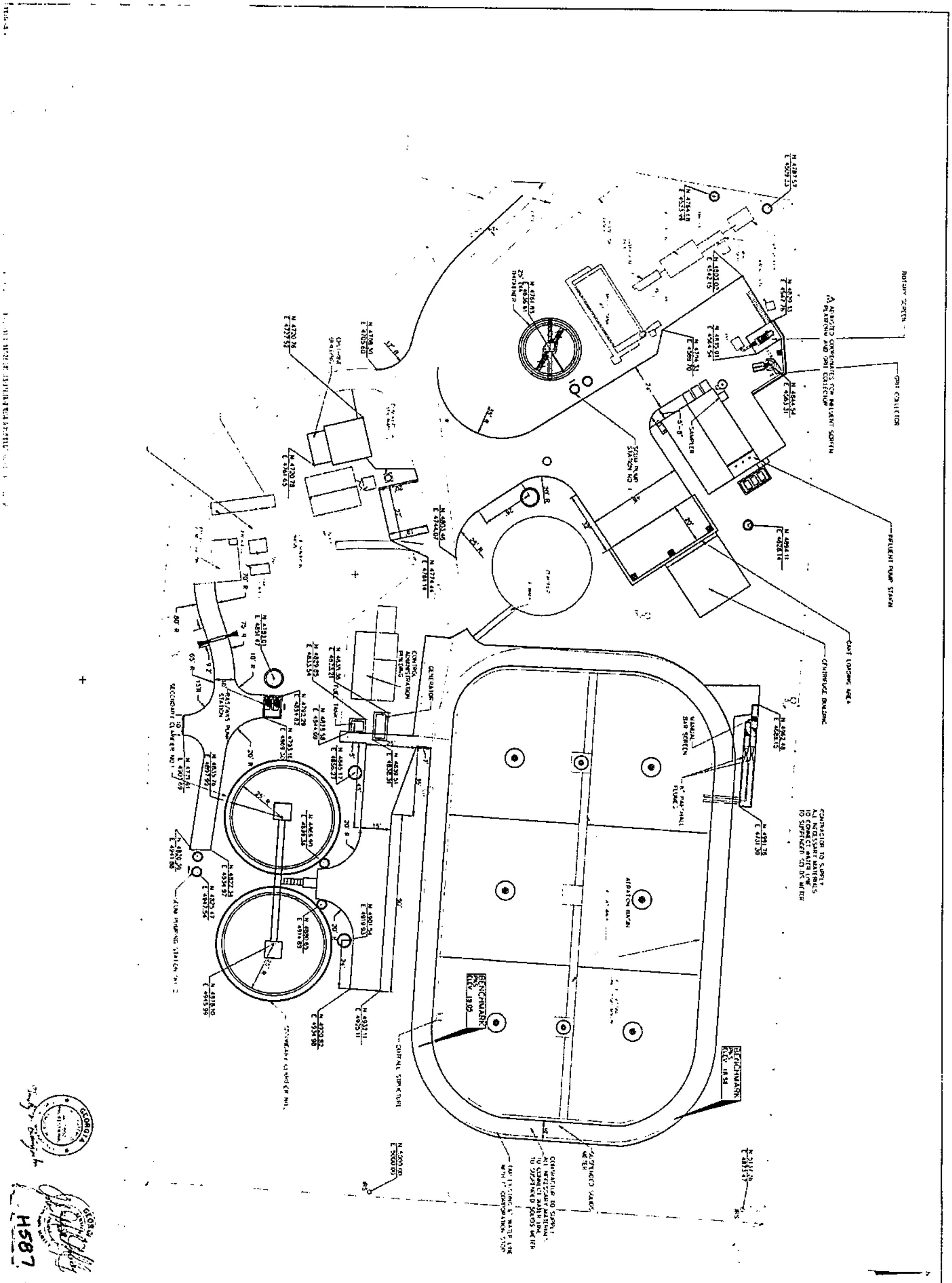
CONTROL BUILDING PLAN & DETAILS

IMPROVEMENTS TO TRAVIS FIELD WASTEWATER TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING SERVICES, INC.
Post Office Box 8101
23 East Charlton Street
Savannah, Georgia 31412
Phone (912) 232-6533

SHEET A1 OF 63

1996 Travis Field Staking Plan



H587

STAKING PLAN

IMPROVEMENTS TO
TRAVIS FIELD WASTEWATER
TREATMENT FACILITY
FOR THE
CITY OF SAVANNAH

EMC ENGINEERING
SERVICES, INC.
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Savannah, Georgia 31412
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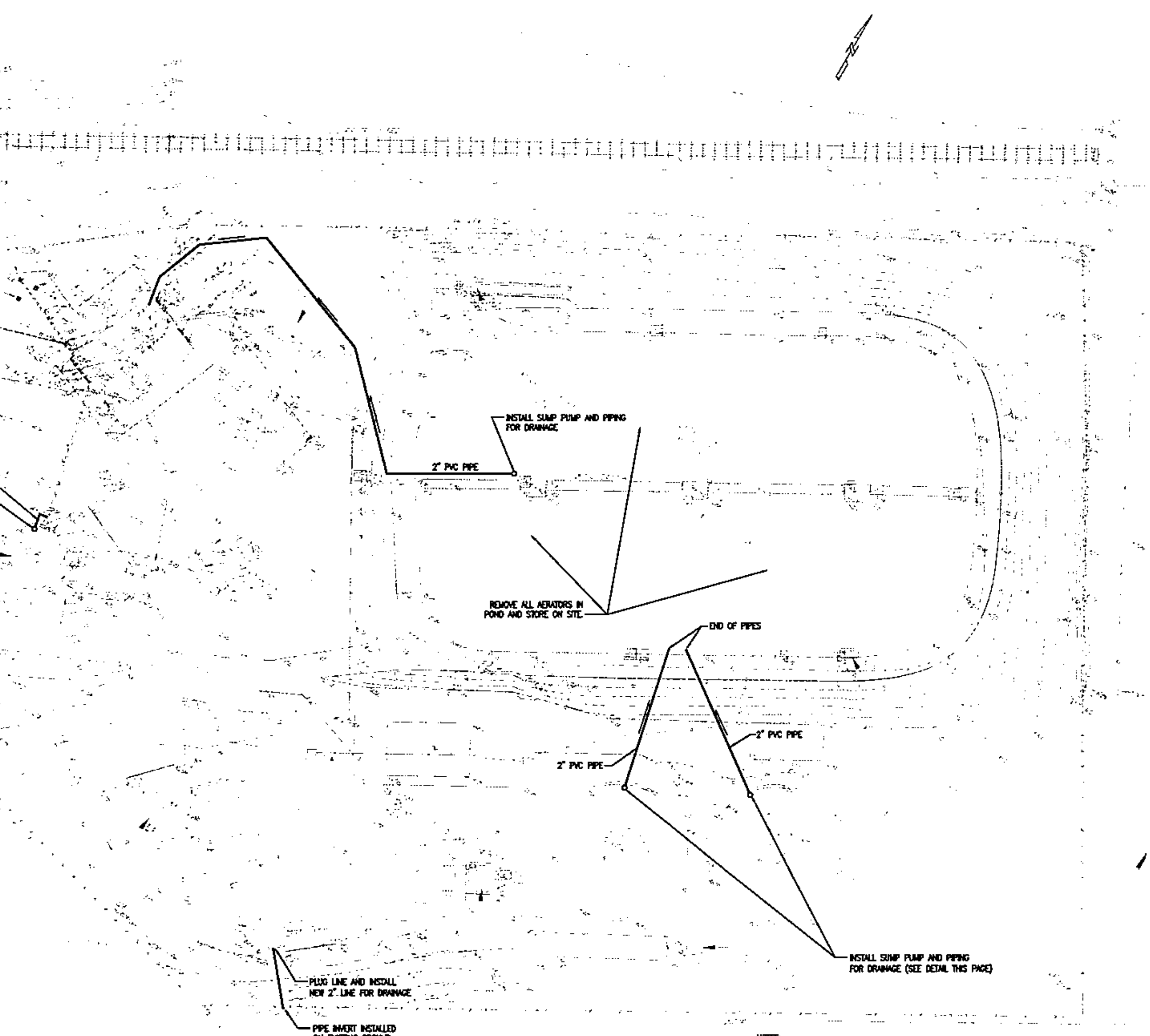
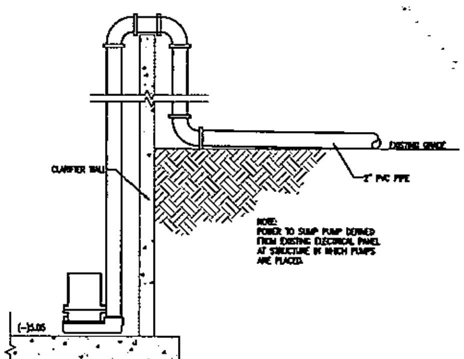
2005 Travis Field Lift Station Upgrade Plan



DEMOLITION PLAN
SCALE: 1" = 20'



CLARIFIER SUMP PUMP AND PIPING DETAIL
SCALE: NTS

Legend

● TO BE REMOVED

NOTES:

1. PUMP CONTENTS OF AERATION POND INTO NEW LIFT STATION ONCE LIFT STATION IS IN OPERATION.
2. ALL SLUDGE AND SUPERNATANT TO BE REMOVED FROM POND.
3. ALL SLUDGE AND SUPERNATANT TO BE REMOVED FROM WWTP FOR DECOMMISSIONING TO BE COMPLETE.

RECORD DRAWING
APRIL 2011

HUSSEY, GAY, BELL & DEYOUNG INC.
CONSULTING ENGINEERS
POST OFFICE BOX 14247
SAVANNAH, GEORGIA
31416-1247
329 COMMERCIAL DRIVE
OFFICE (912) 354-4626
TELEFAX (912) 354-6754

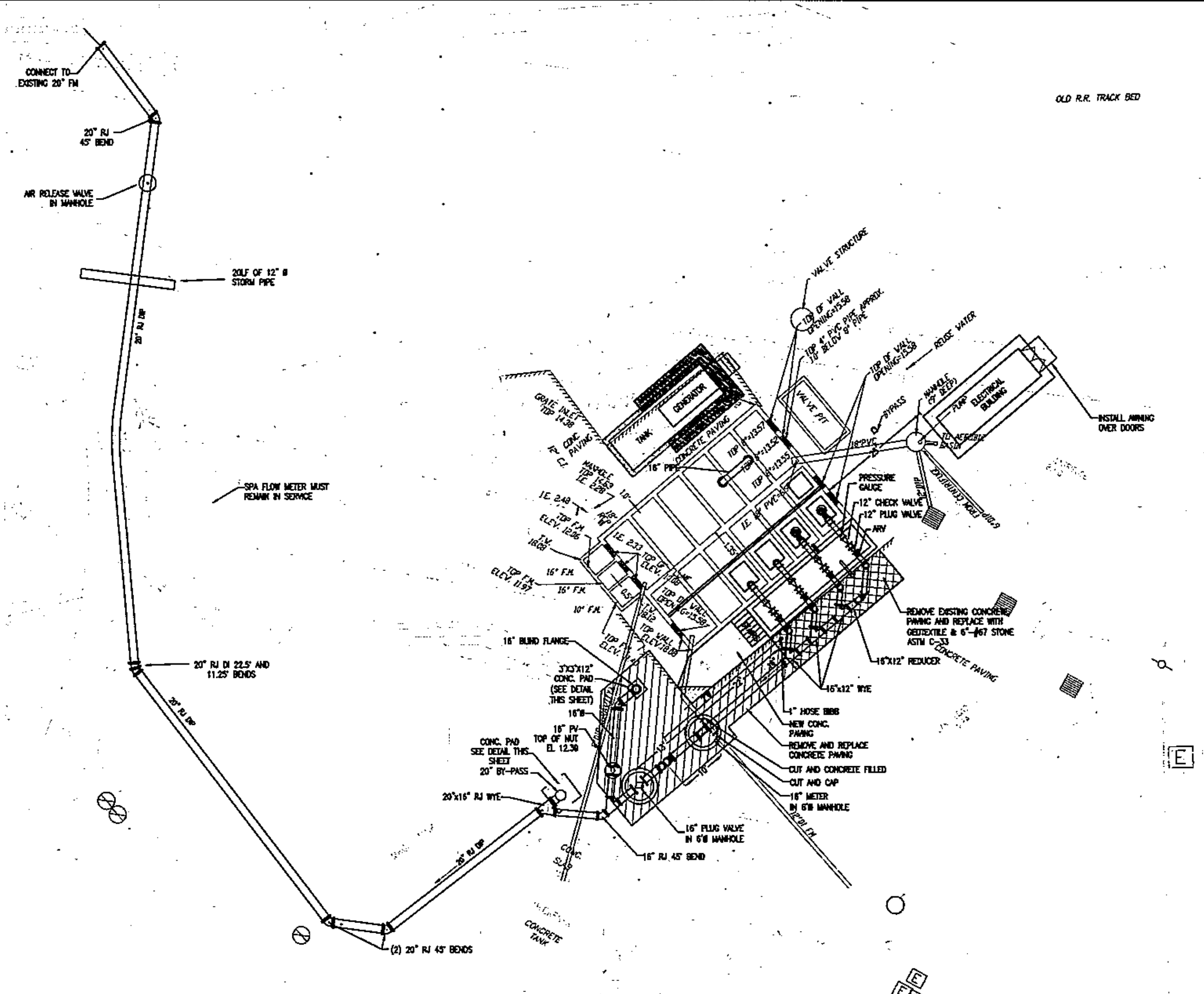
HGBD
A Bell Company

DATE: APRIL 2005
JOB NO. 053213100
SCALE: AS SHOWN

TRAVIS FIELD WATER QUALITY CONTROL PLANT - FLOW DIVERSION
FOR THE
CITY OF SAVANNAH, GEORGIA

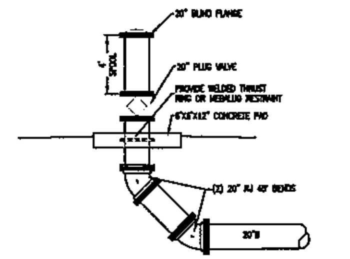
SITE MODIFICATION AND DEMOLITION PLAN

DRAWING NUMBER
TF-02
02 OF 19 SHEETS

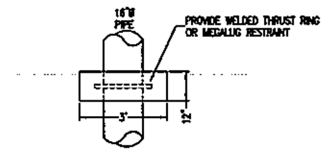


LIFT STATION
SITE IMPROVEMENT PLAN
Scale: 1" = 10'

NOTES:
1. EXISTING ASBUILT INFORMATION PROVIDED BY THE CITY OF SAVANNAH'S IMPROVEMENTS TO TRAVIS FIELD WWTF PLANS DRAWN BY EMC DATED AUGUST 1994.
2. ALL PIPING BELOW GROUND SHALL BE RJ DUCTILE IRON.
3. ALL PIPING ABOVE GROUND SHALL BE FLANGED DUCTILE IRON.
4. ALL MANHOLES SHALL HAVE WATER TIGHT COVERS.
5. ALL DUCTILE IRON PIPE AND FITTINGS WITHIN THE WETWELL SHALL BE EPOXY COATED.



20" BY-PASS CONNECTION DETAIL
SCALE: 1/4" = 1'-0"



BYPASS CONC. PAD DETAIL
Scale: NTS

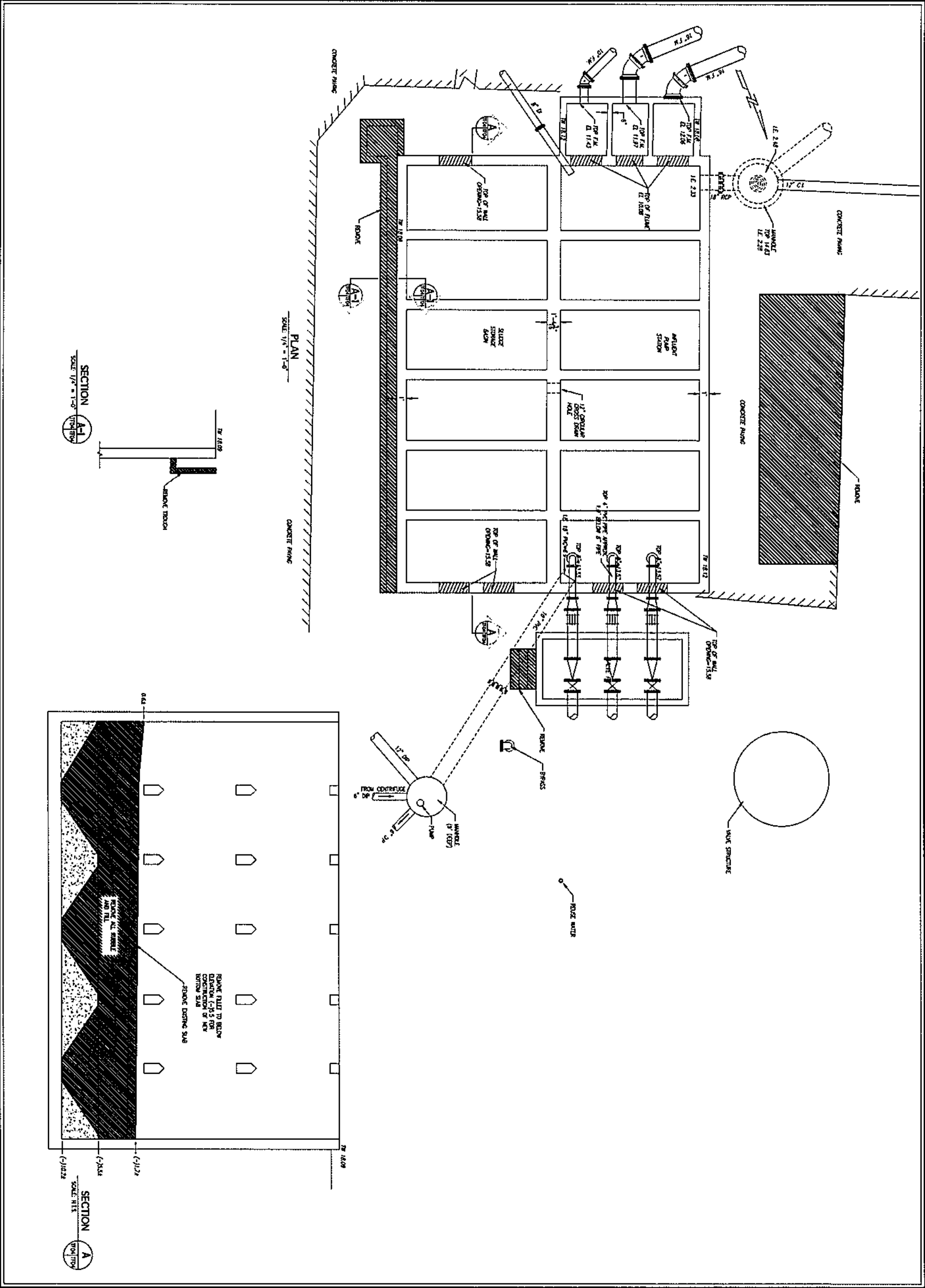
RECORD DRAWING APRIL 2011

HUSSEY, GAY, BELL & DEYOUNG INC.
CONSULTING ENGINEERS
A Bell Company

TRAVIS FIELD WATER QUALITY CONTROL PLANT - FLOW DIVERSION
FOR THE
CITY OF SAVANNAH, GEORGIA
LIFT STATION SITE PLAN & BY-PASS PLAN

DATE: APRIL 2005

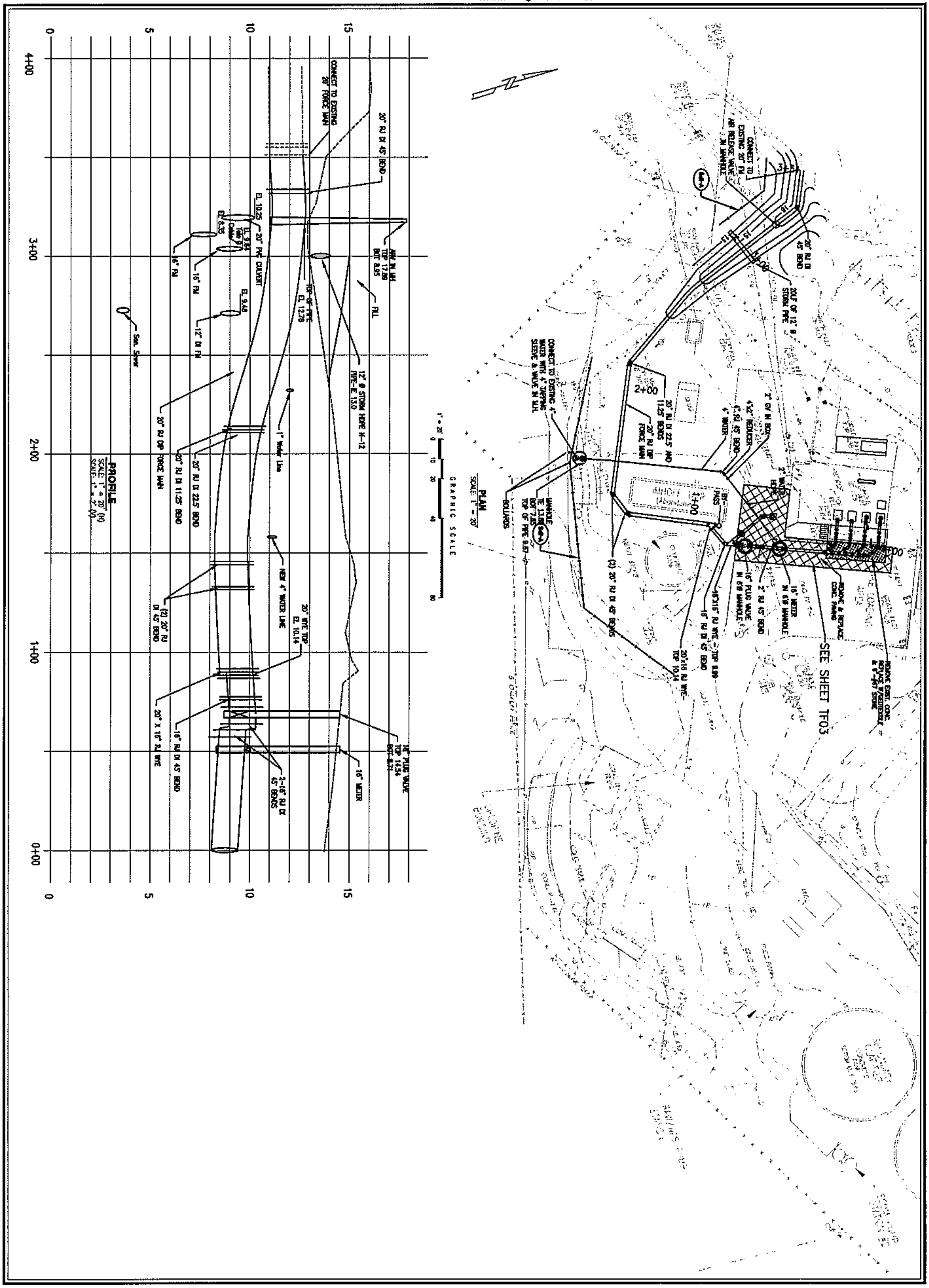
DRAWING NUMBER
TF-03
03 of 19 SHEETS



DRAWING NUMBER TF-04 04 OF 19 SHEETS	TRAVIS FIELD WATER QUALITY CONTROL PLANT - FLOW DIVERSION FOR THE CITY OF SAVANNAH, GEORGIA	DATE: APRIL 2005	HUSSEY, GAY, BELL & DEYOUNG INC. CONSULTING ENGINEERS
	EXISTING L.S. DEMOLITION PLAN	SCALE: AS SHOWN	

HGBD A Bell Company

RECORD DRAWING APRIL 2011



DRAWING NUMBER TF-07 (07 of 19 SHEETS)	TRAVIS FIELD WATER QUALITY CONTROL PLANT - FLOW DIVERSION FOR THE CITY OF SAVANNAH, GEORGIA — PLAN AND PROFILE	HUSSEY, GAY, BELL & DEYOUNG INC. CONSULTING ENGINEERS	RECORD DRAWING APRIL 2011

HGBD — A Bell Company

HUSSEY, GAY, BELL & DEYOUNG INC.
CONSULTING ENGINEERS

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