

DIVISION 2



SECTION 02100

EXCAVATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grading and excavation for roadway and drives.
- B. Grading and excavation for pipelines and channels.
- C. All excavation, formation of embankments and finishing and dressing of graded earth areas, shoulders and ditches.

1.02 RELATED SECTIONS

- A. Section 01400 - Quality Control.
- B. Section 02200 - Backfilling.
- C. Section 02300 - Trenching.
- D. Section 02400 - Asphaltic Concrete Paving.
- E. Section 02420 - Concrete Curb and Gutter and Sidewalk.

1.03 FIELD MEASUREMENT

- A. Verify that shot survey bench mark and intended elevations for the work are as indicated.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 GENERAL

- A. The term "excavation" used hereinafter is defined as "unclassified excavation". Excavation of every description regardless of material encountered within the grading limits of the project, shall be performed to the lines and grades indicated. Satisfactory excavated material shall be transported to and placed in the fill areas within the limits of the work. When directed by the Engineer, unsatisfactory material encountered within the limits of the work shall be excavated below the grade shown and replaced with satisfactory material as directed in order to obtain the required surface condition and density to sustain the subsequent work. Such material ordered as a replacement shall be paid for at the unit prices given in the stated allowance shown in the proposal. Surplus excavated material not required for fill shall remain the property of the Owner and shall be stockpiled in an area on the property designated by the Owner. Excavated material

which is not suitable for use as fill, shall be disposed of by the Contractor off of the Owner's property as part of the contract price. During construction, excavation and filling shall be performed in a manner and sequence that will provide drainage at all times. Except where otherwise shown on the plans or as directed, the unsatisfactory soils shall be removed to a depth required and filled with selected sands and sand clays from borrow excavations that will provide a firm, unyielding subgrade at the specified density. See Section 02200 - Backfilling, for additional details.

- B. All areas covered by the project, including excavated and filled sections and adjacent transition areas, shall be uniformly smooth-graded. The finished surface shall be reasonably smooth, compacted and free from irregular surface changes. The degree of finish shall be that ordinarily obtainable from either bladegrader or scraper operations. The finished surface shall be not more than 0.10 foot above or below the established grade or approved cross section. Gutters and ditches shall be finished so as to permit adequate drainage.
- C. All vegetation, roots, brush, sod, broken pavements, rubbish and other unsatisfactory or surplus material stripped or removed from the limits of construction shall be hauled off the Owner's property and disposed of by the Contractor as part of the contract price.
- D. The Contractor shall be responsible for control of erosion and sedimentation during the work. Silt screens, hay bales or other devices as required shall be installed to prevent off-site migration of eroded materials. Similar devices shall be placed around storm drain catch basins and inlets to prevent the infiltration of soil materials into the underground drainage system. Such devices shall be maintained until all site work is complete. Refer to the Sediment & Erosion Control Plan in the construction drawings.

3.02 CONSERVATION OF TOPSOIL

- A. Areas designated for grading operations that contain a blanket of soil which is more satisfactory for the growth of grass than the embankment material to be placed, as determined by the Engineer, shall be stripped to a depth of approximately four to six inches and placed in convenient stockpiles as directed in the field, for later use as a topsoil blanket on the new graded areas specified herein, or as designated.
- B. Stockpiled material shall be placed in a satisfactory manner to afford drainage.
- C. When grading operations permit, instead of stockpiling, the topsoil shall be hauled and spread directly on the areas to receive topsoil.
- D. Surplus topsoil shall remain the property of the Owner.
- E. This work shall be the responsibility of the Contractor and considered subsidiary to the contract work.

3.03 PROTECTION OF EXISTING SERVICE LINES, UTILITIES AND STRUCTURES.

- A. Existing utility lines and structures that are shown on the drawings or the locations or other utility lines which may exist in the project area, as well as utility lines constructed during excavation operations, shall be protected from damage during excavation, and if damaged, shall be repaired by the Contractor at his expense.

- B. When utility lines that are to be removed or relocated are encountered within the area of operations, the Contractor shall notify the utility company in ample time for the necessary measures to be taken to prevent interruption of the service.
- C. It shall be the Contractor's responsibility to contact all utility companies with services in the area for an accurate location of the respective utilities prior to beginning excavation.

3.04 EXCAVATION OF DITCHES

- A. Ditches shall be cut accurately to the cross sections and grades indicated by the drawings.
- B. All roots, stumps and other foreign matter in the sides and bottom of ditches shall be cut 18 inches below the grades indicated.
- C. Any excessive ditch excavation due to the removal of roots, stumps, or due to over-excavation, shall be backfilled to grade either with satisfactory soils thoroughly compacted, or with suitable stone or cobble to form an adequate ditch paving, as directed, at no additional cost to the Owner.
- D. The Contractor shall maintain all ditches excavated under this specification free from detrimental quantities of leaves, sticks and other debris until final acceptance of the work.
- E. Satisfactory earth material excavated from ditches and channel changes shall be placed in fill areas as directed.
- F. All excess excavation and debris shall be disposed of off-site unless otherwise directed the Engineer.
- G. No diking or berming of soils along the bank will be permitted.
- H. No excavated material shall be deposited within a distance of three feet from the edge of any ditches.
- I. When storm drain pipe terminates in a new ditch, ditch pavement, if specified, shall be constructed immediately as called for on the drawings.
- J. The Contractor shall be responsible for maintaining these newly constructed ditches and take immediate action to keep erosion of the ditch bottom and slopes to a minimum during the life of the contract. No additional compensation will be given to the Contractor for the required maintenance.

3.05 PREPARATION

- A. Identify required lines, levels, contours and datum.
- B. Identify known underground, above ground and aerial utilities. Stake and flag locations.
- C. Protect above and below grade utilities which are to remain.
- D. Protect plant life, lawns and other features remaining as a portion of final landscaping.

- E. Protect bench marks, existing structures, fences, sidewalks, paving and curbs from excavation equipment and vehicular traffic.

3.06 EXCAVATION

- A. Underpin adjacent structures which may be damaged by excavation work, including utilities and pipe chases.
- B. Excavate subsoil required to accommodate building foundations, slabs-on-grade, paving and site structures.
- C. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- D. Hand trim excavation. Remove loose matter.
- E. Remove lumped subsoil, boulders and rock up to 1/3 cubic yard measured by volume.
- F. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- G. Correct unauthorized excavation at no extra cost to Owner.
- H. Stockpile excess excavated material not being used in area designated on Owner's property.

3.07 FIELD QUALITY CONTROL

- A. Field Inspection will be performed under provisions of Section 01400.
- B. Provide for visual inspection of bearing surfaces.

3.08 PROTECTION

- A. Protect excavations by methods required to prevent cave-in or loose soil from falling into excavation.

END OF SECTION

SECTION 02200

BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building perimeter and site structure backfilling to subgrade elevations.
- B. Site filling and backfilling.
- C. Fill and compaction of trenches.
- D. Fill under asphaltic paving.
- E. Consolidation and compaction.
- F. Fill for over-excavation.

1.02 RELATED SECTIONS

- A. Section 02100 - Excavation.
- B. Section 02300 - Trenching.

1.03 REFERENCES

- A. ASTM C 136 - Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM D 1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
- C. ASTM D 1557 - Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using a 10-lb Rammer and 18-in. Drop.
- D. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Type A (Class 1) - Coarse Stone Crushed: Angular, washed natural stone; free of shale, clay, friable material, sand, debris; graded in accordance with ASTM C 136 within the following limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inches	100
1 inch	95
3/4 inch	95 to 100
5/8 inch	75 to 100
3/8 inch	55 to 85
No. 4	35 to 60
No. 16	15 to 35
No. 40	10 to 25
No. 200	5 to 10

B. Type B (Class 2) - Pea Gravel: Natural stone; washed, free of clay, shale, organic matter; graded in accordance with ASTM C 136, to the following:

1. Minimum Size: 1/4 inch
2. Maximum Size: 5/8 inch

C. Type C (Class 3) - Sand: Natural river or bank sand; washed, free of silt, clay, loam, friable or soluble materials or organic matter; graded in accordance with ASTM C 136, within the following limits:

<u>Sieve Size</u>	<u>Percent Passing</u>
No. 4	100
No. 14	10 to 100
No. 50	5 to 90
No. 100	4 to 30
No. 200	0

D. Subsoil: Reused and/or imported, free of gravel larger than 3-inch size, roots and other organic material and trash and approved by the Engineer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify from Engineer fill materials to be reused are acceptable.

3.02 PREPARATION

A. Generally, compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with Type C fill and compact to density equal to or greater than requirements for subsequent backfill material.

C. Prior to placement of aggregate base coarse material at gravel or paved areas, compact subgrade to a minimum of 98% of its maximum dry density in accordance with ASTM D 1557 and AASHTO T-180.

- D. All vegetation, such as roots, brush, heavy sods, heavy growth of grass and all decayed vegetable matter, rubbish and other unsuitable material within the area upon which fill is to be placed shall be stripped or otherwise removed before the fill is started.
- E. In no case will unstable material remain in or under the fill area that will prevent the placement and compaction of subsequent layers to the specified densities.
- F. Sloped ground surfaces steeper than one vertical to four horizontal on which fill is to be placed shall be plowed, stepped and benched, or broken up as directed, in such manner that the fill material will bond with the existing surface.
- G. Prepared surfaces on which compacted fill is to be placed shall be scarified, wetted or dried as may be required to obtain the compaction specified.

3.03 BACKFILLING

- A. Backfill areas at the locations and to lines and elevations shown on the drawings.
- B. Filled areas shall conform to the shape of the typical sections indicated or shall meet the requirements of the particular case.
- C. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- D. Granular Fill: Place and compact materials in continuous layers not exceeding 6 inches compacted depth.
- E. Soil Fill: Place and compact material in continuous layers not exceeding 8 inches compacted depth.
- F. Employ a placement method that does not disturb or damage utilities in trenches.
- G. Maintain optimum moisture content of backfill materials to attain required compaction density.
- H. Slope grade away from buildings minimum 2 inches in 10 ft., unless noted otherwise.
- I. Make grade changes gradual. Blend slope into level areas.
- J. Stockpile surplus reusable backfill materials on Owner's property at Owner's designated site.
- K. Leave fill material stockpile areas completely free of excess unsuitable materials.

3.04 TOLERANCES

- A. Top Surface of Backfilling: Plus or minus one tenth from required elevations.

3.05 . FIELD QUALITY CONTROL

- A. Field inspection will be performed by the Engineer.
- B. Tests and analysis of fill material will be performed in accordance with ASTM D 1557 (AASHTO T-180).
- C. Compaction testing will be performed in accordance with ASTM D 1557 (AASHTO T-180) and ASTM D 2922.
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest at no additional cost to Owner.
- E. Frequency of tests: As required by the testing firm or as directed by the Engineer.
- F. Proof roll all compacted fill surfaces under paving with a loaded tandem wheel dump truck with no detectable deflection.

3.06 PROTECTION OF FINISHED WORK

- A. Protect all finished Work.
- B. Recompact fills subjected to vehicular traffic.

3.07 COMPACTION REQUIREMENTS

- A. The compaction of fill materials shall meet the following requirements as determined by the maximum density obtained at optimum moisture content by an approved laboratory.
 - 1. Fill under buildings 100%
 - 2. Fill under paved areas 98%
 - 3. Fill in other areas 95%
- B. The Contractor shall be responsible for compaction of the existing soils to meet the above compaction requirements.
- C. The Contractor will be responsible for compacting the subgrade to the required density by whatever means necessary.

3.08 SCHEDULE

- A. Fill under grassed areas.
 - 1. Subsoil fill to finished grade.
- B. Fill under asphaltic concrete pavement.
 - 1. Type C fill to 8 inches below finished paving elevation.

END OF SECTION

SECTION 02300

TRENCHING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Excavate trenches for utilities.
- B. Compacted bedding under fill over utilities.
- C. Backfilling and compaction.

1.02 RELATED SECTIONS

- A. Section 02100 - Excavation.
- B. Section 02200 - Backfilling.

1.03 FIELD MEASUREMENTS

- A. Verify that survey benchmark and intended elevations for the Work are as shown on the drawings prior to proceeding with construction.

PART 2 PRODUCTS

2.01 FILL MATERIALS

- A. Types A, B, and C subsoil materials as specified in Section 02200.

2.02 BED MATERIALS

- A. Type 1 Material: As specified for Type A in Section 02200.
- B. Type 2 Material: As specified for Type B in Section 02200.
- C. Type 3 Material: As specified for Type C in Section 02200.
- D. Subsoil Material: As specified in Section 02200.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify fill materials to be reused are acceptable.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum, which pass through work area.
- B. Maintain and protect existing utilities remaining, which pass through work area.
- C. Protect plant life, lawns, rock outcropping and other features remaining as a portion of final landscaping.
- D. Protect benchmarks, existing structures, fences, sidewalks, paving and curbs from excavation equipment and vehicular traffic.
- E. Protect above and below grade utilities which are to remain.
- F. Cut out soft areas of subgrade not capable of insitu compaction. Backfill with Type 3 fill and compact to density equal to or greater than requirements for subsequent backfill material.

3.03 EXCAVATION

- A. Excavate subsoil required for storm sewer, sanitary sewer, or water line piping.
- B. Cut trenches sufficiently wide to enable installation of utilities and inspection at a minimum of 1 foot each side of pipe.
- C. Hand trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- D. Remove lumped subsoil, boulders and rock larger than 3 inches in diameter.
- E. Correct unauthorized excavation at no cost to Owner.
- F. Correct areas over-excavated by error.
- G. Stockpile excess excavated material, suitable for use as fill, in a designated area on the Owner's property. Excess excavated material unsuitable for use as fill shall be removed from the site and disposed of by the Contractor as part of the contract price.

3.04 BEDDING

- A. Support pipe during placement and compaction of bedding fill.

3.05 BACKFILLING

- A. Backfill trenches to elevations shown on plans.
- B. Systematically backfill to allow maximum time for maximum compaction. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Granular Fill: Place and compact material in continuous layers not exceeding 6 inches compacted depth.

- D. Soil Fill: Place and compact material in continuous layers not exceeding 6 inches compacted depth.
- E. Employ a placement method that does not disturb or damage foundation perimeter, pipe, or conduit in trench.
- F. Maintain optimum moisture content of backfill materials to attain required compaction density.
- G. Stockpile surplus reusable backfill materials on site in a location approved by Owner.
- H. Leave fill material stockpile areas completely free of excess unsuitable materials.

3.06 TOLERANCES

- A. Top Surface of Backfilling: Plus or minus one tenth from required elevations.

3.07 FIELD QUALITY CONTROL

- A. Field inspection will be performed by the Engineer and/or Engineer-approved independent testing firm.

3.08 PROTECTION OF FINISHED WORK

- A. Protect all finished Work.
- B. Recompact fills subjected to vehicular traffic.

END OF SECTION

SECTION 02400

ASPHALTIC CONCRETE PAVEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Aggregate Base and Asphaltic Concrete Pavement.
- B. Sampling and Testing.

1.2 RELATED SECTIONS

- A. Section 01410 - Testing and Laboratory Services.
- B. Section 02100 - Excavation.
- C. Section 02200 - Backfilling.
- D. Section 02460 - Thermoplastic Pavement Markings.

1.3 REFERENCES

- A. SCDOT SS - South Carolina State Highway Department Standard Specifications, 2007 Edition.
- B. The Federal Highway Administration Manual on Uniform Traffic Control Devices for Streets and Highways, 2000 Edition.
- C. ASTM D 1188 - Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
- D. ASTM D 1556 - Density of Soil in Place by the Sand-Cone Method.
- E. ASTM D 1557 - Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft).
- F. ASTM D 2726 - Bulk Specific Gravity of Compacted Surface-Dry Specimens.
- G. ASTM D 2922 - Density of Soil and Soil-Aggregate in Place by Nuclear Methods.
- H. ASTM D 3017 - Moisture Content of Soil and Rock in Place by Nuclear Methods.

1.4 QUALITY ASSURANCE

- A. Except as specified herein or as indicated, work and materials shall be in accordance with the SCDOT SS. The provisions therein for method of measurement and payment do not apply.
- B. Obtain materials from same source throughout.
- C. Coordinate with testing laboratory to provide testing as specified in Section 01410 - Testing Laboratory Services.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Do not produce or place asphaltic concrete when the weather is rainy or foggy, when the base course is frozen or has excess moisture, or when the ambient temperature is less than 40 degrees F in the shade away from artificial heat.

1.6 SUBMITTALS

- A. Job-Mix Formula: Submit the mix design, including mixing temperature, for approval. The mix design shall include a certified laboratory analysis of mix composition with marshall stability value, void content, and flow. After mix design approval, job mixes shall conform to the range of tolerances specified in SCDOT SS. Obtain acknowledgment of receipt prior to asphaltic concrete placement. Submit additional data regarding materials if the source of the materials changes.

B. Certificates

1.1 Base course

1.7 BARRICADES AND SIGNALS

- A. Provide and maintain temporary signs, signals, lighting devices, markings, barricades, and channelizing and hand signaling devices in accordance with the South Carolina Manual on Uniform Traffic Control Devices for Streets and Highways to protect personnel and new construction from damage by equipment and vehicles until the surface is approved by the Engineer.

1.8 WARRANTY

- A. Contractor shall provide an unconditional maintenance free warranty in writing for all asphaltic concrete paving against defects in workmanship and materials for a period of one (1) year. The warranty period shall begin at the date the final pay request is approved. The warranty shall be executed by the paving subcontractor and cosigned by the General Contractor.
- B. Condition at Expiration of Warranty Period: At his own expense and just before expiration of the one (1) year warranty period, the Contractor shall make such repairs as may be necessary to produce a pavement which shall:

1. Have a contour substantially conforming to that of the pavement indicated on the drawings, and free from depressions of any kind exceeding 1/8" deep as measured between any points 4 feet apart on a line conforming substantially to the original contour of the paved area.
2. Be free from cracks or depressions showing disintegration of the surface mixture.
3. Contain no disintegrated surface mixture.
4. Not have been reduced more than 3/8" in thickness in any part.
5. Have a base free from cracks or defects which will cause its disintegration or settling of the pavement.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Bituminous Concrete Mix: SCDOT SS, Section 402 and 403, Type C for surface course; Type A for intermediate course.
- B. Base Course: SCDOT SS, Section 305.
- C. Prime: SCDOT SS, Section 406, MC-30, RC-30 or EA-P.

2.2 MIX PLANT

- A. SCDOT SS, Section 401, Type C.

PART 3 EXECUTION

3.1 INSTALLATION AND APPLICATION

- A. Provide a base course with a prime coat and a bituminous concrete surface course. Subgrade preparation shall be as specified in Section 02200, "Backfilling".

3.2 BASE COURSE PLACEMENT

- A. Begin spreading base material at the point nearest the source of supply. Permit traffic and hauling over the base. Fill ruts formed by traffic and reroll. After base course placement, continue machining and rolling until surface is smooth, compacted, well bonded, and true to the designed cross section. Compact to 100 percent ASTM D 1557 maximum dry density. Maintain the base smooth and true to grade and cross section until asphaltic concrete placement.
- B. The completed thickness of the base course shall be within +3/4 inch or -1/2 inch of the required thickness. The average thickness shall not be less than the design thickness.

3.3 APPLICATION OF PRIME COAT

- A. The prime coat shall not be applied until the stabilized aggregate base course has seasoned sufficiently to permit a uniform penetration. The base shall be dry when the prime is applied.
- B. The rate of application shall be from 0.25 to 0.30 gallons per square yard.
- C. When it is necessary to maintain traffic on a road or a section of road before the prime coat has time to sufficiently dry to prevent pickup, the Contractor shall apply sand as a cover. The cost of the material and performing this work shall be included in the cost of the base course or other items of work and no direct payment will be made.

3.4 PLACING ASPHALTIC CONCRETE PAVEMENT

- A. Placing Temperature - Minimum temperature of asphaltic concrete during placement into mechanical spreader shall be 250 degrees F. Mixtures which have a lower temperature shall be rejected.
- B. Joints - Where new pavement abuts existing bituminous pavement, cut existing surface course along straight lines approximately 6 inches from edge. Cuts shall be vertical and extend full depth of surface course. Prior to bituminous concrete placement, apply asphalt cement to exposed edges of cold joints.
- C. Spreading and Finishing Equipment - Spread the bituminous concrete to a uniform density and produce a smooth finish, true to cross section and free from irregularities. Provide adjustable screeds to shape the surface to true cross section.
- D. Asphaltic Concrete Placement - As continuous as possible. Place in maximum 2-inch lifts. Avoid passing rollers over unprotected edges of bituminous concrete prior to bituminous concrete cooling. If rollers pass over unprotected edges of bituminous concrete prior to cooling, cut bituminous concrete back to expose full depth of bituminous concrete. Immediately prior to resumption of bituminous concrete placement, coat exposed edges of bituminous concrete with asphalt cement. When bituminous concrete placement resumes, rake the hot bituminous concrete against asphalt cement and compact.
- E. Featheredges - Accomplish featheredging by raking out the larger aggregate as necessary and sloping the pavement uniformly throughout the featheredge to create a smooth transition. Unless indicated otherwise, featheredge transition shall be 10 feet.
- F. Compaction - SCDOT SS for equipment and compaction procedures, modified to compact bituminous concrete to 96 percent of maximum laboratory density. Finished surfaces shall be uniform in texture and appearance and free of cracks and creases.
- G. Protection - No vehicular traffic shall be allowed on pavement for a minimum of 6 hours after final rolling, or until asphaltic concrete has cured, whichever is longer.

3.6 TOLERANCES OF PAVEMENT

- A. Flatness: Maximum variation of 1/4 inch measured with a 10 foot straight edge.
- B. Compacted Scheduled Thickness: Within -1/4 inch to +1/2 inch of design thickness.

3.7 FIELD QUALITY CONTROL

- A. Sampling: Provide new materials where samples are taken.
Take the number and size of samples required to perform the following tests.
 - 1. Bituminous Concrete Sampling
 - a. Job Mix: Take one initial sample and one sample for every 400 tons or fraction thereof.
 - b. Thickness: Take one sample for every 500 square yards or fraction thereof.
 - c. Density: One field test for every 1000 square yards or fraction thereof, and one laboratory test for the project. Provide minimum 4-inch diameter cores.
 - 2. Base Course Sampling
 - a. Thickness: Take one sample for every 500 square yards or fraction thereof.
 - b. Density: One field test for every 250 square yards or fraction thereof, plus two (2) tests, minimum, at each street area to receive concrete pavers and one laboratory test for the project.
- B. Testing: Provide for each sample.
 - 1. Bituminous Concrete Testing
 - a. Job Mix: Determine gradation and bitumen content.
 - b. Thickness: Maximum allowable deficiency shall be 1/4 inch less than the indicated thickness.
 - c. Density, In Place: ASTM D 2922 and ASTM D 3017; cored sample ASTM D 1188 or ASTM D 2726.
 - 2. Base Course Testing
 - a. Thickness: Maximum allowable deficiency shall be 1/2 inch less than the indicated thickness.
 - b. Density: ASTM D 1556 or ASTM D 2922 and ASTM D 3017.

END OF SECTION

SECTION 02410

PATCHING ASPHALTIC CONCRETE PAVEMENT

PART I GENERAL

1.01 SECTION INCLUDES

- A. Patching of existing asphalt pavements or asphalt resurfaced pavements for water lines, sewer lines, storm drains lines or utility service lines.

1.02 RELATED SECTIONS

- A. Section 02100 - Excavation.
- B. Section 02200 - Backfilling.
- C. Section 02500 – Storm Drainage System.
- D. Section 02625 – Sewer Force Main Systems.

1.03 REFERENCES

- A. SCDOT Standard Specifications, 2007 Edition.
- B. SCDOT Manual of Uniform Traffic Control Devices for Streets and Highways, Latest Edition.
- C. SCDOT Work Zone Safety Handbook, Latest Edition.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with the SCDOT standards.
- B. Obtain materials from same source throughout.

1.05 TESTING REQUIREMENTS

- A. Submit proposed mix design of each class of mix for review prior to commencement of work.

1.06 SUBMITTALS

- A. Certificates: Provide certificates stating that materials supplied comply with the specifications. Certificates shall be signed by asphalt producer and Contractor.
- B. Mix Design: Submit mix design for base and pavement courses to Engineer for acceptance.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Construct asphaltic courses only when atmospheric temperature is above 40 degrees F, when underlying base is dry and when weather is not rainy.
- B. Conform to SCDOT Standard Specifications except where more stringent requirements are specified herein.
- C. Apply bituminous prime and tack coats only when the ambient temperature in the shade has been at least 60 degrees F. for 12 hours immediately prior to application.
- D. Place concrete only when atmospheric temperature is above 40 degrees F.

PART 2 PRODUCTS

2.01 PAVEMENT MATERIALS

- A. Primer: Homogeneous medium curing liquid asphalt. Type MC-30.
- B. Tack Coat: Type SS-1.
- C. Asphalt Cement: ASTM D946. Type AC-20.
- D. Aggregate for Mix: SCDOT Type 1.

2.02 ASPHALT PAVING MIX

- A. Use dry materials to avoid foaming. Mix uniformly.
- B. Topping Course: 4.8 to 6.8 percent of asphalt cement by weight in mixture.

2.03 BASE COURSE MATERIAL

- A. The base course material shall be as specified on the drawings and shall conform to the SCDOT Standard Specifications.

2.04 CONCRETE

- A. Concrete and reinforcing steel shall conform to requirements of Section 03250.
- B. Concrete shall be 3500 psi high early strength.

PART 3 EXECUTION

3.01 INSPECTION

- A. Verify compacted trench backfill is dry and ready to support a compacted base course.
- B. Verify compacted base course is dry and ready to support paving and imposed loads.
- C. Verify that reinforcing steel is lean, of the proper size, properly positioned and free from kinks or other defects before pouring concrete (for patches requiring concrete base).

- D. Verify that the concrete base (where required) has set up for the proper length of time before covering patch with asphalt.

3.02 TRENCH BACKFILLING

- A. The trench shall be backfilled and compacted in accordance with Section 02200.
- B. All trenches across roadways shall be covered at the end of each working day and open to traffic.
- C. Trenches shall be brought level with the existing pavement using gravel base for at least the top 6 inches which shall be compacted in place. Any settlement or holes which develop shall be promptly filled by the Contractor at his expense with additional gravel base.
- D. Pavement patch shall be brought level with the existing pavement using gravel base for at least the top 6 inches which shall be compacted in place. Any settlement or holes which develop shall be promptly filled by the Contractor at his expense with additional gravel base.

3.03 PATCH PREPARATION

- A. The existing pavement shall be sawcut at the required distance from the edge of the trench just prior to the final application of gravel base or concrete as called for on the plans.
- B. Immediately after sawcutting the existing pavement as described above the patch area shall be cleaned of extraneous material. The area shall be cleared to the required depth in neat lines and all excess material shall be removed.
 - 1. For patches to receive gravel base, the final application of gravel shall be made and compacted to bring the level up to the required distance below the existing pavement.
 - 2. For patches with concrete base the reinforcing steel (if required) shall be placed in the patch area and supported by concrete block, brick or approved chair supports the proper distance above the sub-base. Reinforcing steel shall not be allowed to rest on the sub-base. After the steel placement has been inspected and approved, concrete shall be poured and the top troweled to an even surface at the required depth below the existing pavement.
 - 3. Concrete shall be allowed to set at least 24 hours. During this time traffic shall be maintained by placing steel plates or other approved or bridging material across the trench. Such bridging shall be at the Contractor's expense.
- C. Traffic shall not be allowed to cross the sawcut edges until the final asphalt course has been laid.

3.04 PLACING ASPHALT PATCH

- A. The asphalt surface shall be placed as soon as practical after the patch preparation is finished.
- B. Prior to placing the asphalt, a primer shall be used if placed over a gravel base. A tack coat shall be used if placed over concrete and shall be used between layers if more than one layer is required. Such primer or tack coat shall be at the Contractor's expense.
- C. Place the asphalt within 24 hours of priming the base or placing the tack coat.
- D. Place the asphalt to the compacted thickness identified on the plans.
- E. Compact pavement by rolling. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
- F. Develop rolling pattern with consecutive passes to achieve required compaction and even and smooth finish, without roller marks.
- G. Asphalt pavement shall meet all SCDOT requirements unless otherwise stated on the plans or in the specifications.

3.05 TOLERANCES

- A. Compaction and Density Requirements:
 - 1. Base and sub-base: Compact to 98% as measured by ASTM D698.
 - 2. Asphalt Pavement: Minimum acceptable density of in place material shall be 98% of recorded laboratory specimen density.
- B. Allowable Variation in Thickness:
 - 1. Base Course: (+\-) 1/2".
 - 2. Surface (wearing) Course: (+\-) 1/8".
- C. Surface Smoothness: Test finished surface of each asphalt course for smoothness using a 10'-0" straight edge. Intervals of tests shall be as directed by the Engineer. Surfaces will not be acceptable if exceeding the following:
 - 1. Base Course: 1/2" in 10'-0".
 - 2. Surface (wearing) Course: 1/4" in 10'-0".
- D. Laboratory shall test in place courses for compliance with specified density, thickness and surface smoothness. Contractor shall seek Engineer's approval for testing locations and number of tests.
- E. Laboratory shall take two 4" diameter cores per 1,000 sq. yards of paved surface (400 LF of roadway) at locations directed by the Engineer.

- F. Contractor's duties relative to testing shall include:
1. Notifying laboratory of conditions requiring testing.
 2. Coordinating with Engineer and laboratory for field testing.
 3. Paying costs for testing performed and for retesting where initial tests reveal nonconformance with specified requirements.
 4. Repair holes resulting from coring to match existing surface.

3.06 TRAFFIC CONTROL

- A. Comply with State Manual of Uniform Traffic Devices for Streets and Highways.
- B. Maintain vehicular and pedestrian traffic during paving operations as required for other construction activities. Flagmen may be required at busy intersections.
- C. Provide flagmen, barricades, warning signs and warning lights for movement of traffic and safety and to cause the least interruption of work.

3.07 MARKING AND SIGNAGE

- A. Pavement marking and road signs shall comply with SCDOT and the local municipalities' standards as applicable.

3.08 CLEANING AND PROTECTION

- A. At completion of each operation, remove excess or spilled materials from site. Dump or spread no excess asphalt materials on the project site.
- B. After placement of surface course, no vehicular traffic shall be allowed on pavement until it has cooled.

END OF SECTION

SECTION 02420

CONCRETE CURB AND GUTTER AND SIDEWALK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cast-in-place concrete curb and gutter construction.

1.2 RELATED SECTIONS

- A. Section 01410 - Testing and Laboratory Services.
- B. Section 02100 - Excavation.
- C. Section 02400 - Asphaltic Concrete Pavement.
- D. Section 03250 - Concrete.

1.3 REFERENCES

- A. ACI 347 - Recommended Practice for Concrete Form Work.
- B. PS 1 - Construction and Industrial Plywood.

1.4 QUALITY ASSURANCE

- A. Obtain materials from same source throughout.

1.5 FIELD CONSTRUCTED MOCK-UP

- 1. Prior to installation of concrete walks, construct sample mock-up panel to verify implementation of each specified finish treatment. Sample panels shall represent complete walk installation, including finishes, edge and joint treatment, for quality of appearance, materials, construction and workmanship. Locate mock-ups at site as directed by the Engineer. Obtain approval of panels from the Engineer prior to beginning installation. Prepare new mock-up panel(s) as necessary to obtain desired appearance. Quality of appearance, materials, construction and workmanship, as established by the approved panel, shall be the standard by which finished work is judged acceptable. Multiple mock-up panels may be required. Mock-up panel shall be a minimum of 5' x 5' each. Approved panels shall remain in place throughout the duration of the Project, until such time as all walks have been installed and found acceptable by the Engineer, at which time the panel shall be removed in its entirety. Mock-up panel shall not remain part of the finished work.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Do not place concrete in temperatures less than 40 degrees F without Engineer's approval.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Concrete Materials: Comply with requirements of applicable Division 3 sections for concrete materials, curing materials and others as required.
- B. Forms: Steel, of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms to form radius bends as required. Coat forms with nonstaining type coating that will not discolor or deface surface of concrete.
- C. Joint Fillers: Resilient premolded bituminous impregnated fiberboard units complying with ASTM D 1751, FS HH-F-341, Type II, Class A; or AASHTO M 153, Type I.
- D. Joint Sealants: Standard joint sealant specifically manufactured for intended purpose; Sikaflex[®] 1C SL or prior approved equal.

2.2 MIX DESIGN

- A. Mix design shall comply with requirements of Section 03250.
- B. Design mix to produce normal weight concrete consisting of portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce the following properties:
 - 1. Compressive Strength: 3,000 psi, minimum at 28 days, unless otherwise indicated on Plans.
 - 2. Slump Range: 2" - 4" maximum.
 - 3. Air Entrainment: 5% to 8%.

2.3 TREE GRATES

Tree grates as manufactured by Neenah Foundry Company, or approved equal. All grates shall be two-piece, cast iron, with matching cast iron frame. One size is required: overall nominal size of 36" x 48", equal to Neenah R-8814-A, Rectangular.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify reinforcement and other items to be cast into concrete are accurately placed, held securely, and will not cause hardship in placing concrete.

3.2 PREPARATION

- A. Form Construction

1. Set forms to required grades and lines, rigidly braced and secured.
2. Clean forms after each use, coat with form release agent as often as required to ensure separation from concrete without damage.

B. Concrete Placement

1. Do not place concrete until subgrade and forms have been checked for line and grade.
2. Place concrete using methods which prevent segregation of mix.
3. Automatic machine may be used for curb and gutter and sidewalk placement at Contractor's option. Machine placement must produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

C. Joint Construction - Curb and Gutter

1. Weakened Joints: Provide joints at intervals of 6 feet maximum. The joint shall be made by cutting the concrete with a trowel or by other acceptable methods. Saw cutting joints shall not be allowed.
2. Expansion Joints: Preformed expansion joints 3/4 or one (1) inch thick, extending the full depth of the concrete curbing, shall be constructed at all radius points, junctions with existing concrete, inlets and manholes, and at not more than 50 foot intervals in continuous runs of curb. Leave expansion joints 1/2" from level with finished surface. Fill remaining 1/2" with Sikaflex® 1C SL joint sealer to flush with finished surface. Protect joint sealer until it has cured enough to handle foot and vehicular traffic.

D. Joint Construction - Sidewalks

1. Control Joints: Provide joints at intervals noted on drawings, both ways. The joint shall be made by cutting with trowel or other acceptable means. Saw cutting joints shall not be allowed.
2. Expansion Joints: Preformed expansion joints 1/2 inch thick, extending full depth of walk to within 1/2 inch of finished surface. Fill last 1/2 inch with standard joint sealer, to flush with top of joint. Apply sealant so as to prevent discoloration or defacement of surface of concrete. Provide expansion joints at a minimum of 20 feet on center, both ways; in addition, provide expansion joints where walks abut all existing vertical structures, building foundations, concrete collars, and between existing and new concrete pavements.

E. Joint Construction - Concrete Collars

1. Expansion Joints: Preformed expansion joints 1/2 inch thick, extending full depth of collar to within 1/2 inch of finished surface. Fill last 1/2 inch with Sikaflex® 1C SL joint sealer, to flush with top of joint. Apply sealant so as to prevent discoloration or defacement of surface of concrete. Provide expansion joints at a

minimum of 25 feet on center; in addition, provide expansion joints where collars abut building foundations, existing concrete pavement, walks, new concrete pavement, and all structures.

- F. Place concrete continuously between predetermined expansion joints. Do not break or interrupt successive pours such that cold joints occur.
- G. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.

3.3 TREE GRATES:

Install tree grates and frames per manufacturer's recommendations and standard installation details. Frames shall in all cases be secured into surrounding concrete collars.

3.4 FINISHING

A. Curb and Gutter

- 1. Broom finish by drawing fine-hair broom across concrete surface parallel to line of traffic. Repeat procedure as required to provide fine line texture. Alternate direction of broom finish on adjacent squares of concrete.

B. Sidewalk

- 1. All concrete walks shall be finished as detailed.

C. Concrete Collar

- 1. Broom finish by drawing fine-hair broom across concrete surface parallel to length of collar. Repeat procedure as required to provide fine line texture.

3.5 PATCHING

- A. Notify Engineer immediately upon removal of forms.
- B. Patch imperfections.

3.6 DEFECTIVE CONCRETE

- A. Modify or replace concrete not conforming to required levels and lines, details and elevations.
- B. Repair or replace concrete not properly placed or of the specified type.
- C. Remove and replace defective concrete as directed, at no additional cost to the Owner.

3.7 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 01410.

3.8 PROTECTION

- A. Protect concrete from damage until acceptance of work.

END OF SECTION

SECTION 02460

THERMOPLASTIC PAVEMENT MARKINGS

PART I GENERAL

1.1 SECTION INCLUDES

- A. Application of permanent thermoplastic reflectorized pavement marking materials and associated permanent raised reflective pavement markers.

1.2 RELATED SECTIONS

- A. Section 02400 - Asphaltic Concrete Pavement.

1.3 REFERENCES

- A. SCDOT Standard Specifications, Latest Edition.
- B. SCDOT Supplemental Specifications.
- C. FHA Manual on Uniform Traffic Control Devices (SCMUTCD).

PART 2 PRODUCTS

2.1 MATERIALS

- A. Thermoplastic Compound: AASHTO M 249 with the following adjustments:
 - 1. The material may be shipped in the granulated form rather than the block form.
 - 2. For longitudinal long line and channelization markings, the material may be either hydrocarbon or Alkyd based.
 - 3. All handwork consisting of stopbars, crosswalks, legends and symbols shall be Alkyd Based Material only.
- B. Glass Beads: AASHTO M 247 - Type 1.
- C. Primer-Sealer: A primer-sealer as recommended by the manufacturer of the thermoplastic pavement marking material shall be utilized on all Portland Cement pavement surfaces and all bridge surfaces that have not been overlaid with asphalt. The primer-sealer also shall be utilized on any type of pavement prior to the placing of Railroad Crossing Symbols. Primer-sealer shall be used on Asphaltic Concrete pavement surfaces if recommended by the manufacturer of the thermoplastic pavement marking material. The primer-sealer shall form a continuous film which will mechanically adhere to the pavement and shall neither discolor nor cause any noticeable change in the pavement outside of the finished pavement markings.

- D. Retroreflective Pavement Markers (RPM): RPMs shall be provided and installed in accordance with ASTM D 4280 and SCDOT Standard Specifications for Highway Construction (2007 edition) Section 630.

2.2 EQUIPMENT

- A. Requirements: AASHTO M 249 and as expanded by SCDOT Supplemental Specification.

PART 3 EXECUTION

3.1 PREPARATION OF SURFACE

- A. All surfaces to be painted shall be thoroughly cleaned of all dust, dirt, grease, oil, and all other foreign matter before application of the marking paint.
- B. When waterborne paint is utilized, temperatures at the heat exchanger of the paint truck shall not exceed 150° F (66° C). Paint shall not dwell in the exchanger for more than two hours.
- C. Unless otherwise permitted by the Engineer, no markings shall be applied to areas of pavement when any of the following conditions apply:
 - 1. Any moisture or foreign matter is present on the surface.
 - 2. The air temperature is below 50° F (10° C).
 - 3. The relative humidity is above 85 percent.
- D. All markings shall be sufficiently dry before opening to traffic.
- E. The wet film thickness for all markings shall be 15 mils. Place glass beads at a minimum rate of six (6) pounds per gallon of paint.

3.2 APPLICATION OF THE PRIMER-SEALER

- A. Where used, the primer-sealer shall be sprayed on the pavement surface where the lines are to be applied. The application thickness and curing time on the pavement prior to thermoplastic application shall be governed by the recommendations of the manufacturer of the primer-sealer.

3.3 APPLICATION OF THE MARKING MATERIAL

- A. All longitudinal markings shall be placed with a truck-mounted applicator except when approved by the Engineer. Such a case may occur where the length of a particular marking is too short, or the curvature too great, to permit efficient use of the liner. Transverse markings may be applied with a portable unit.
- B. The markings shall be straight or of uniform curvature and shall conform uniformly with tangents, curves and transitions. Symbols shall be of dimensions shown in the SCMUTCD. Markings must be of the dimensions and placed as shown on the Pavement Marking Plans. The Contractor shall provide, at his own expense, sufficient control

points to serve as guides for the application of markings.

- C. The finished line markings shall be free from waviness and the lateral deviations shall not exceed two (2) inches in fifteen (15) feet. Any greater deviation shall be sufficient cause for requiring the Contractor to remove and correct, at his expense, any symbol markings not meeting the dimensional requirements shown in the SCMUTCD.
- D. The Contractor shall protect the markings until dry by placing guarding or warning devices as necessary. In the event any vehicle should cross the wet marking, such a marking shall be reapplied and any tracking lines made by the moving vehicle shall be removed by the Contractor at no additional expense.
- E. To avoid poor quality, markings shall be placed only when the surface of the pavement is sufficiently dry as determined by visual inspection and the pavement temperature is minimum 55° F and the air temperature is minimum 50° F. No work will be allowed when any moisture is visible on the pavement surface.
- F. Thermoplastic markings to be applied between December 15 and March 15 shall only be applied in the proper weather conditions, as outlined above. The Engineer may disallow application on any days when the weather is cold and/or rainy and there is some question as to whether the surface temperature will be above 55° F for a period of time adequate to obtain quality markings. The Engineer may disallow application on any day when, in the Engineer's opinion, moisture conditions are not satisfactory for obtaining quality markings.
- G. An adequate number of personnel experienced in the handling and application of this type of material shall be provided by the Contractor to assure the work is done properly. Work shall be done only during daylight hours, and all markings shall be sufficiently dry, before sunset, to permit crossing by traffic. All protective devices shall be removed before sunset to allow free movement of traffic at night.
- H. The marking material shall be applied at a temperature that will provide best adhesion to the pavement and shall be between 390° F and 420° F as recommended by the manufacturer. The material shall be heated uniformly throughout and shall have a uniform disbursement of binder, pigment, and glass beads when applied to the surface of the pavement.
- I. All extruded lines 12 inches or less in width shall be applied with a die that equals the width of the line. All extruded lines greater than 12 inches may be applied with two dies whose combined widths equal the width of the line.

3.4 RATE OF APPLICATION

- A. Marking Material: Marking material shall be applied at the specified widths and at a rate to result in a new material thickness at the center of the line as specified below:

90 mils (2.3 mm): Edge lines and median lines
(4 inch solid white, 4 inch solid yellow, 4 inch broken yellow)

90 mils (2.3mm): Lane lines (4 inch broken white)

90 mils (2.3mm): Center lines on two-lane roadways
(4 inch broken yellow and 4 inch solid yellow)

125 mils (3.2mm): All others not listed above

The edge of the line shall, under all circumstances, have a thickness not less than 75% of the specified center thickness.

- B. Glass Beads: "Drop-on" glass beads shall be mechanically applied to the surface of the marking material immediately after the material is applied to the pavement surface, and while the marking material is still molten to ensure that the beads will be held by and mechanically embedded in the surface of the material. The beads shall be uniformly distributed over the entire surface of the marking and shall be applied at a minimum rate of 12 pounds per 100 square feet of stripe.

3.4 RETROREFLECTIVE PAVEMENT MARKINGS

- A. Markers may be bonded to the pavement by using either the epoxy method or the bituminous adhesive method. Ensure that the ambient temperature and road surface temperature during application is at least 50° F for use of the epoxy method or 40° F for use of the bituminous adhesive method of bonding.
- B. Installation of the RPMs by either method shall be in accordance with the SCDOT Book.

3.5 WARRANTY

- A. The Contractor shall transfer to the Owner the warranty on thermoplastic materials issued by the manufacturer. The Contractor shall also furnish the Owner the normal warranty for material for a stated period beginning with the last date of marking application on the project.

3.6 INSPECTION AND ACCEPTANCE OF WORK

- A. All thermoplastic markings shall be inspected for proper line thickness and width, proper adhesion, and proper cycle length. The markings shall also be observed both day and night to determine whether all requirements of the Contract have been met. Any markings failing to have satisfactory appearance, either day or night, shall be reapplied by the Contractor at his own expense.
- B. The final acceptance of the thermoplastic pavement markings will be delayed for a period of one-hundred eighty (180) days after the last date of marking on the project to permit observation of performance. The Contractor shall be required to replace any markings or markers that, in the opinion of the Engineer, have not performed satisfactorily during this one-hundred eighty day period due to defective materials and/or workmanship in manufacture or application.

END OF SECTION

SECTION 02500
STORM DRAINAGE SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Storm drainage piping, fittings, and accessories.
- B. Catch basins, junction boxes and drop inlets.

1.02 REFERENCES

- A. ANSI/ASTM C76 - Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
- B. American Association of State Highway and Transportation Officials Specification M-196.
- C. American Association of State Highway and Transportation Officials Specification M-294-94.

1.03 RELATED SECTIONS

- A. Section 02200 - Backfilling.
- B. Section 02300 - Trenching.
- C. Section 03250 - Concrete.

PART 2 PRODUCTS

2.01 DRAINAGE PIPE MATERIALS

- A. Reinforced Concrete Pipe: ANSI/ASTM C76, Class III, IV, or V concrete pipe with mesh reinforcement and inside nominal diameter as shown on plans.
- B. Corrugated Steel Pipe: Riveted with circumferential seams 3" x 1", and inside diameter as shown on plans unless otherwise noted.
- C. Corrugated Steel Perforated Pipe: Riveted with circumferential seams 3" x 1", thirty - 3/8" round holes per square foot of pipe surface for the full 360 degrees and inside nominal diameter as shown on plans unless otherwise noted.
- D. Corrugated Polyethylene Pipe: AASHTO M 294-94, type S or SP and inside nominal diameter as shown on plans unless otherwise noted.
- E. Corrugated Polyethylene Perforated Pipe: Same as D.
- F. Construction Fabric Pipe Wrap: Shall be Marifi 140 N or approved equal.

2.02 CATCH BASINS, DROP INLETS, JUNCTION BOX FRAMES AND GRATES

- A. Basin Lid and Frame: Cast iron construction, as specified on the plans. All grates are to be bicycle safe.
- B. Manhole castings shall be cast iron meeting ASTM Serial Designation A48-62, Class 30B. They shall be "Anti-Rattle" type.
- C. Shaft construction to be 8" concrete brick or reinforced precast concrete basin sections, lipped male/female dry joints; nominal size, 3 feet square unless shown otherwise on the plans.
- D. Base Pad: Cast-in-place 3000 psi concrete. Level top surface to receive concrete brick or pre-cast concrete section.
- E. All brick or concrete block manholes or catch basins shall have 3/4" grout on outside and inside to seal and waterproof from ground water.

2.03 JUNCTION BOXES

- A. Lid and Frame: Cast iron construction, removable lid, nominal lid and frame diameter of 24 inches as shown on the plans.
- B. Shaft construction to be 8" concrete brick or reinforced precast concrete basin sections, lipped male/female dry joints; nominal size, 3 feet square unless shown otherwise on the plans.
- C. Base Pad: Cast-in-place 3000 psi concrete. Level top surface to receive concrete brick or pre-cast concrete section.
- D. Manholes used as junction boxes shall have the following diameters based upon the largest size pipe:

15" pipe	--	4 feet
18" pipe	--	5 feet
- E. For larger pipes, pre-cast manhole junction boxes must have prior approval of the Engineer.
- F. Pre-cast concrete manholes shall meet ASTM Specifications, Serial Designation C478-64T or latest revision and have "O" ring gasket joints meeting ASTM Specifications, Serial Designation D443-65 or latest revision.

2.04 BRICK

- A. Brick shall meet ASTM Serial Designation C26 for common brick, Grade C.

2.05 CEMENT MORTAR JOINTS

- A. All concrete pipe shall be laid with cement mortar joints. The mortar mixture shall be one part Portland Cement and two parts clean sand by volume.
- B. Only enough water shall be used to make a stiff, workable mortar and no more than 5.5 gallons of water per sack of cement shall be used.

2.06 CONCRETE MATERIALS

- A. Portland Cement shall conform to Section 3250 and the specifications of ASTM, Serial Designation C-150-62 or latest revision.
- B. Cement shall be stored in a weather-tight enclosure.
- C. Hydrated lime shall meet the specifications of ASTM, Serial Designation C207-49, or latest revision.
- D. Fine aggregate shall conform to the following ASTM Specifications, latest revisions:
 - 1. For concrete: Serial Designation C33-66T
 - 2. For masonry mortar: Serial Designation C144-62T
- E. Coarse aggregate for concrete shall consist of crushed granite conforming to the current ASTM Specifications C33. Aggregate shall be cleaned, hard and uncoated.
- F. Water for mortar and concrete must not be contaminated by salt, oil, acid or other material which may be harmful.

2.07 REINFORCING STEEL

- A. Reinforcing steel shall be of the lengths and sizes shown on the plans.
- B. Reinforcing steel shall be of approved deformed type and meet all requirements of ASTM Standard Specifications for new Billet Steel Reinforcement Bars, Serial Designation A150-62T. Bars will be structural or intermediate grade open hearth steel.

2.08 BACKFILL MATERIALS

- A. Reused or imported subsoil as specified in Section 02200 and approved by the Engineer.
- B. Type B for any pipe crossing beneath roadways.
- C. Type C shall be utilized in areas of poor soil conditions as directed by the Engineer.

PART 3 EXCAVATION

3.01 EXAMINATION

- A. Contractor shall notify Engineer so the trench cut or excavation base can be verified if it

is ready to receive work and excavations, dimensions and elevations are as indicated on drawings.

- B. Beginning of installation means acceptance of existing conditions.

3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fill material of fine aggregate.
- B. Remove large stones or other hard matter which could damage drainage tile or impede consistent backfilling or compaction.

3.03 INSTALLATION - PIPE

- A. Lay pipe to slope gradients noted on drawings with maximum variation from true slope of 1/8 inch in 10 feet.
- B. Increase compaction of each successive lift. Do not displace or damage pipe when compacting.
- C. Storm drain pipe and appurtenant structures shall be installed in accordance with Section 02300 - Trenching and Section 02200 - Backfilling.
- D. All pipe shall be laid with the bells uphill.
- E. Clean the pipe ends and wet before the joint is made.
- F. Apply stiff mortar to the lower half of the bell of the pipe already laid and the upper half of the tongue of the pipe to be laid. The joint shall then be made and drawn tight. Bitumastic joints are required for concrete pipe.
- G. Additional mortar shall be applied to the outside to fill any unfilled portion of the groove.
- H. Backfill shall be done so as not to disturb the mortar joints.
- I. Fill must be approved by the Engineer before placement.
- J. Spoil from the excavation may not be utilized at these locations unless specifically approved by the Engineer.
- K. In all locations where storm water drainage pipe crosses beneath roadways, select granular fill shall be used to backfill above the pipe.
- L. When completed, each pipe line shall show a neat circular bore when lamped.
- M. Prior to placing perforated pipe and after the trench has been excavated, place an approved construction fabric in the trench, place a bed of Class 1 gravel on the fabric, install the perforated pipe on the gravel bed and backfill over pipe with Class 1 gravel and compact. Overlap fabric over pipe, backfill and compact remainder of trench with select material.

3.04 INSTALLATION - CATCH BASINS, DROP INLETS AND JUNCTION BOXES

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad with provision for storm sewer pipe end sections.
- C. Establish elevations and pipe inverts for inlets and outlets as indicated.
- D. Mount lid and frame level in grout, secured to top cone section to elevation indicated.
- E. Inverts shall be smooth with uniform slopes from invert to invert.
- F. Brick structures shall have every fifth course of brick laid as headers. Other courses shall be stretchers.
- G. All mortar joints shall be full.
- H. Inside mortar joints shall be rubbed full and struck.
- I. The inside and outside of the brick work shall be covered with 0.5 inches of mortar.

3.05 FIELD QUALITY CONTROL

- A. Testing shall be in accordance with General Provisions.

3.06 PROTECTION

- A. Protect pipe from damage or displacement until backfilling operation is in progress.
- B. Protect drainage piping and catch basins from siltation during construction with the use of filter fabric.

END OF SECTION

SECTION 02625

SEWER FORCE MAIN SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Sewer Force Main piping, fittings, and accessories.
- B. Sewer Pump Station piping, fittings, checks, and valves.

1.02 RELATED SECTIONS

- A. Section 02200 - Backfilling.
- B. Section 02300 - Trenching.
- C. Section 03250 - Concrete.

1.03 REFERENCES

- A. ANSI/ASTM A377 - Ductile Iron Pressure Sewer Pipe.
- B. ANSI/ASTM A48 - Gray Iron Castings.
- C. ANSI/AWWA C-110/A21.10 p Ductile Iron Fittings for Dimensions with 80-60-03 Metal per ASTM A339-55.
- D. ANSI/ASTM D2774 - Recommended Practice for Underground Installation of Thermoplastic Pressure Piping.
- E. ANSI/ASTM D2241 - Polyvinyl Chloride (PVC) (SDR 26) (160 psi) Sewer Pipe.
- F. ANSI/ASTM A21.11 - Rubber Gasket Joints for Cast Iron Ductile Iron Pressure Fittings.
- G. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe.
- H. AWWA C600 - Installation of Gray and Ductile Iron Pressure Pipe and Fittings.
- I. ANSI/AWWA C104 - Cement Mortar Lined Ductile Iron Pipe.
- J. ANSI/AWWA C151 - Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Molds, for Water or Other Liquids.
- K. ANSI/ASTM C478 - Precast Concrete.
- L. AWWA C600.4 - Testing of Sewer Force Mains.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the Work of this Section.

1.05 SUBMITTALS

- A. Submit all product data.
- B. Submit product data for pipe, pipe accessories, manholes, manhole accessories, valve and valve accessories.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. U.S. Pipe
- B. American Cast Iron Pipe Company.
- C. Griffin Pipe Products Company.
- D. McWane Cast Iron Pipe Company.
- E. J M Pipe and Pipe Products.
- F. Scepter Pipe.
- G. DeZurik - Plug Valves.
- H. Clow Corporation.
- I. Mueller Company.
- J. Crispin - Air Valves. (Multiplex Manufacturing Co.)
- K. M & H Valve & Fitting Co.
- L. Vulcan - Water Tight Manholes.
- M. Sumter Machinery Company Inc. - Standard Manhole Frames and Covers.
- N. Tindall Concrete Products Inc. - Manholes.
- O. Thunderline Corporation - Link Seals.
- P. Substitutions: Under provisions of Section 0550.

2.02 GENERAL

- A. These specifications shall apply to the materials to be furnished and installed to complete the sewer force main installations in accordance with the plans.

- B. All pipe and fittings shall be of the class and type as indicated on the plans and/or proposal and designated here within.
- C. Intermixing of different types of pipe will not be permitted unless specified on the plans or with approved written permission by the Engineer.
- D. All pipe shall be of first quality with smooth interior and exterior surfaces, free from cracks, blisters, honeycombs and other imperfections, and true to theoretical shapes and forms throughout the full length.
- E. All pipe shall be subject to the inspection of the Engineer at the pipe plant, trench, or point of delivery, for purpose of culling and rejecting pipe (independent of laboratory test), which does not conform to the requirements of these specifications. Such pipe shall be marked by the Engineer, and the Contractor shall remove it from the project site upon notice being received of its rejection.
- F. All sewer force mains installed shall be Polyvinyl Chloride (PVC) pipe for force mains 16 inches in diameter or less.
- G. All sewer force mains buried greater than 14 feet in depth shall be bedded in Class 1 materials 1 foot above the crown of the pipe.
- H. As specific specifications are cited, the designation shall be construed to refer to the latest revision under the same specification number, or to superseding specifications under a new number, except for provisions in revised specifications, which are clearly inapplicable.
- I. All sewer force main materials shall conform with one or more of the specifications cited for each material classification noted below.

2.03 SEWER FORCE MAIN MATERIALS

- A. Ductile Iron Pipe:
 - 1. Pipe shall be Class 350, sewer coat lined pipe and conform to the following standard specifications: ANSI/AWWA C-151/A21.51, ASTM 746, and federal specification WW-P-421-D.
 - 2. Cast Iron and Ductile Iron pressure pipe must conform to ASTM A-377, latest revision.
 - 3. Pipe shall be mechanical, push-on, flanged, or boltless ball joint (as needed or as shown on the plans) and conform to standard A21.11 (AWWA C-111) and federal specification WW-P-421-C; for flanged joints ASA-B-16.1 and for boltless ball joints ASA-B-16-B.
 - 4. Boltless ball joints shall lock and be watertight and permit a deflection of up to 15 degrees. The locking device shall include a spherical socket, spherical retainer and lead locking wedge.

B. Polyvinyl Chloride Pipe (PVC)

1. PVC Pressure pipe shall be in accordance with the requirements of ASTM D2321, latest revision; ASTM D2241, latest revision; and shall bear the National Sanitation Foundation Seal.
2. Pipe 4 inches in diameter and greater shall be DR-25 - C900. (AWWA C900).
3. Pipe less than 4 inches in diameter shall be SDR 21.
4. Rubber rings shall be of uniform solid cross-section and conform to ASTM D1869 or the manufacturer's recommendations.

C. Plug Valves

1. All Sewer Force Main Valves shall be plug valves (unless otherwise noted).
2. Plug valves shall be Pratt, or DeZurik series 100 only.
3. Plug valves buried in the ground shall be furnished with mechanical joint type end connections and a standard 2 inch square operating nut.
4. Plug valves shall be epoxy coated inside and out.
5. Plug valves located inside sewer pump stations or buildings are to be flanged with hand-wheel actuators.
6. All plug valves shall be eccentric plug valves unless otherwise specified.
7. All plug valves shall be rated for 175 psi water working pressure and 350 psi hydrostatic test pressure.
8. All plug valves shall be 100% ported and gear actuated.

D. Tapping Sleeves & Valves

1. Tapping sleeves will be true mechanical joints (no fabricated sleeves). Mueller model H-615 or approved equal.
2. All tapping sleeves will be for cast iron, ductile iron, or PVC pipe. (Unless otherwise noted).
3. All tapping valves shall be Mueller model H-687 or approved equal. Tapping valve shall be laid on side with plug valves attached as operating unit.
4. Tapping valves shall have a standard 2 inch square operating nut.

E. Valve Box

1. Valve boxes shall be cast iron adjustable screw type with extension to grade.

2. As required, extension stems shall be provided to raise valve operating nut to 36 inches below grade.
3. Each valve box is to be mounted flush with the proposed grade.
4. Two (2) Concrete Bricks will be required between the valve and valve box.
5. Valve boxes in grassed areas shall have a precast concrete collar mounted flush with the final grade.
6. Valve boxes in pavement areas shall be brought flush with the final grade.
7. Valve boxes to read "SEWER" on the top cover.

F. Check Valves

1. Check valves shall not be direct or buried.
2. Check valves installed in sewer pump stations or valve vaults that are to be installed in the horizontal or vertical direction shall be a flanged lever and spring operation check valve, M & H model 259-02 or approved equal.

G. Sewer Air Release Valves

1. All air release valves shall be A.R.I. Model D-025 with back flushing nose, quick disconnect, couplings ½" shutoff, 1" diameter or approved equal.
2. Stainless steel quick disconnect coupling by OPW Kamlock 2" with gasket.
3. Valve inlet shall be 2 inches in diameter and shall be furnished with a 2 inch stainless steel ball valve with lever handle: Hammond No. 0433 or No. V108-32 or approved equal. Installed with handle up for opening.

2.04 PIPE ACCESSORIES

- A. Fittings: Same material as pipe, molded or formed to suit pipe size and end design, in required "T", bends, elbows, clean out, reducers, traps, and other configurations required unless otherwise shown on plans.
- B. Link Seal: Wall seals for all pipe entering pump station shall be installed in accordance with the manufacturer's installation instructions. All link seals shall be grouted in place after pipe placement.

2.05 MANHOLES

- A. Frame and Cover: Iron castings conforming to ANSI/ASTM A48, Class 30C iron. Minimum manhole cover diameter shall be 23 inches, and the manhole ring and cover assembly shall not weigh less than 285 pounds. For elevations above the 50 year flood level, frames and covers shall be U.S. Foundry USF 668 Ring KL cover, or approved equal. For elevations below the 50 year flood level, frames and covers shall be watertight U.S. Foundry USF 579 Ring and DC-SSG cover, or approved equal.

- B. Manholes to be in accordance with City standards.
- C. Manhole Steps: Neoprene coated steel steps cast into manhole wall, 11 inches square and projecting from the wall 6 inches. Steps are to be a maximum of 16 inches on center.

2.06 FILL MATERIAL

- A. Ductile Iron Pipe: Approved subsoil as specified in Section 02200.
- B. Polyvinyl Chloride (PVC) Plastic Pipe: Bed in accordance with bedding detail on plans using material specified in Section 02200.

PART 3

3.01 GENERAL

- A. The Contractor shall furnish all material and labor, and construct the sewer force mains shown on the plans, including all clearing, grubbing, excavating, sheathing, backfilling, foundations, manholes, and other appurtenances, as shown on the plans or specified.
- B. The work shall include all ditching, diking, pumping, bailing, draining, dewatering, flushing, testing, and all provisions necessary to protect and maintain buildings, fences, water and gas pipes, drainage culverts, power and telephone lines and cables, and other structures.
- C. The Contractor shall be responsible for the cleaning away of all rubbish, surplus materials, and the furnishing of all materials, tools, implements, and labor required to build and put in complete working order the specified sewers and all structures appertaining thereto.
- D. All sewers and appurtenances shall be cleared of all foreign debris.

3.02 SURVEYS, POINTS, AND INSTRUCTIONS

- A. The Owner, through the Engineer, shall furnish control survey lines and grades as may be necessary. The Contractor shall create his own alignment between each horizontal control points and be responsible for establishing elevations of said points. This shall not relieve the Contractor of the responsibility to make careful and accurate measurements and for constructing the work accurately to the lines and grades furnished by the Engineer.
- B. The Contractor shall give the Engineer reasonable notice (48 hours minimum) of his requirements for such control survey lines and grades as he may require.
- C. The Contractor shall furnish and place, as directed, all necessary guide boards and appurtenances, and give such other incidental assistance at the site as may be required by the Engineer for staking out the work.
- D. The Contractor shall temporarily suspend construction operations which interfere with the Engineer's activities. Operations will be suspended for as long as the Engineer deems necessary.

- E. The Contractor shall carefully preserve the points furnished by the Engineer.
- F. The Contractor shall receive no extra compensation for any materials or services furnished by him incidental to these operations of the Engineer.

3.03 ORDER OF WORKS

- A. The Owner reserves the right to direct the Contractor as to which portions of work should be constructed first, and upon order of the Engineer to verify that any complete portion of work is as specified and acceptable for service.

3.04 HIGHWAYS, STREETS, AND PUBLIC PROPERTY

- A. The Contractor's operations in highways or public streets shall be confined to as small a space as is practicable, so as not to cause undue inconvenience to the public or abutting properties, and shall be subject to the approval of the Engineer.
- B. The Contractor shall obtain, by agreement with property owner, any additional space required for construction on private property at no cost to the Owner of the Project.
- C. The Contractor shall fully adhere to the SCDOT Encroachment Permit and all other encroachment permits while operating in any public right-of-way.
- D. Roadway crossings shall be accomplished by open ditch construction or by boring under pavement as required by the State.
- E. All materials and modes of operation shall be approved by the Engineer prior to the start of work.
- F. Pavement, base, and subgrade courses which must be removed for constructing sewers and appurtenances in or across highways, roadways, and streets shall be replaced with the same general class and type of material used in the initial construction unless specified differently on the plans or in the specifications.
- G. Through traffic shall be maintained at all times during construction of sewers across all streets and highways. If the open cut method is used, two separate cuts must be made and one lane of traffic must be open at all times.
- H. All construction techniques shall comply with current editions of the State Highway Department Standard Specifications and Traffic Control Manual.
- I. The Contractor shall provide suitable bridges, approved by the Engineer, for any area where traffic will cross a trench.

3.05 EXISTING UTILITIES AND STRUCTURES

- A. The Contractor shall give written notice (copy to the Engineer) to all Highway Departments, Municipalities, and Public Service Corporations whose poles, wires, pipes, conduits, survey monuments, bench marks, or other structures/utilities may be affected by his operations.

- B. Any existing utilities, structures, monuments, damaged by the Contractor shall be repaired or replaced by the Contractor at his own expense.
- C. The approximate position of certain known underground lines are shown on the plans for information only. Existing small service lines are not shown.
- D. The Contractor shall locate all utilities by use of an electronic pipe locator or other satisfactory methods.
- E. The Contractor shall excavate and expose all existing underground lines in advance of trenching operations.
- F. The Contractor may, with the Owner's or Engineer's consent, remove any obstructions to his operations, but the obstructions shall be removed and replaced at the Contractor's expense.
- G. Removing and relaying of such lines and appurtenances due to interference with the proposed line and grade, in the opinion of the Engineer, will be completed at the expense of the Contractor, unless otherwise shown on the plans or in the contact documents.

3.06 POTABLE WATER PROTECTION

- A. Adequate provision shall be made for the protection of potable water supplies from possible leakage from sewers located near water lines.
- B. There shall be no physical connection between a public water supply system and a sewer system.
- C. Where possible, sewer mains should be located at least ten (10) feet horizontally from existing or proposed water mains. If local conditions prevent a lateral ten (10) foot separation or a sewer is to cross a water main then:
 - 1. Sewer will be laid in a separate trench, with the elevation of the top of the sewer main at least eighteen (18) inches below the bottom of the water main, or;
 - 2. Sewer will be laid in a separate trench as the water main with the water main located on a bench of undisturbed earth, and with the elevation of the top of the sewer at least eighteen (18) inches below the bottom of the water main, or;
 - 3. If local conditions prevent the eighteen (18) inch vertical separation, then the sewer will be laid under the water main and both the water and the sewer shall be constructed of ductile iron pipe for a distance of ten (10) feet on each side of the crossing. The water and sewer lines will be pressure-tested to assure water tightness prior to backfilling.
- D. When conditions require a sewer line to cross over a water main, both the water main and sewer line shall be constructed of ductile iron pipe for a distance of ten (10) feet on each side of the crossing. The sewer main pipe shall be centered at the crossing and both water and sewer lines will be pressure-tested to assure water tightness prior to backfilling.

- E. If conditions arise which prevent application of the above techniques, Contractor shall obtain written approval from the Engineer prior to construction of the specific problem area.
- F. Water/sewer line separation shall be in accordance with Section R62-58-4D(12) of the State Primary Drinking Water Regulations.

3.07 LIGHTS AND PROTECTION

- A. The Contractor shall erect and maintain such strong and suitable barriers and such warning lights as will effectively prevent the occurrence of any accident to health, limb, or property.
- B. Lights shall be maintained between the hours of sunset and sunrise, during any period of low visibility or as directed by the Engineer.
- C. Where pipe lines are to be constructed in the streets, highways or roadways, the Contractor shall take all precautions and comply with all requirements, as may be necessary, to protect the improvements, including installation and maintenance of warning signs, lights, and barricades for the protection of traffic.

3.08 EXCAVATION

- A. Contractor to excavate in accordance with Section 02100 and the following.
- B. The Contractor shall do all excavation of whatever substances are encountered to the depth shown on the plans.
- C. Prior to any excavation, Contractor shall provide adequate protection (as long as necessary to prevent damage) for any part or parts of the project site to remain (lawns, sidewalks, fences, landscape, hydrants).
- D. Any and all damaged items shall be repaired or replaced in such a manner that the items in question are returned to their original or better condition at the Contractor's expense.
- E. Unstable soil shall be removed and replaced with mechanically tamped gravel or crushed stone at no additional cost to the Owner. The Engineer shall determine the depth of removal of unstable soil.
- F. Excavation for manholes shall have a minimum of twelve (12) inches clearance on all sides.
- G. Remove any water accumulated in excavation at no additional cost to Owner.
- H. Excavation shall not be carried below the required level. Excess excavation below the required level shall be backfilled at the Contractor's expense with earth, sand, gravel, or concrete, as directed by the Engineer, and thoroughly tamped to the required proctor.
- I. At locations where existing walls or fences will be removed to permit the installation of the proposed sewer line, the Contractor shall remove and reset the wall/fence as rapidly as practicable to permit the installation. Fences/walls shall be reset in their original

location in condition equal or better than prior to their removal. The Contractor will be required to establish temporary fencing or barriers for protection of children, livestock, during construction.

3.09 TRENCHING

- A. Contractor to construct all trenching in accordance with Section 02300 and the following.
- B. Trench width shall be wide enough to provide adequate space for workman to place and joint the pipe properly.
- C. Trench bottom to be rounded to allow pipe to rest firmly on undisturbed soil or compacted bedding.
- D. Bell hoes shall be excavated accurately to size by hand. In rock, excavation shall be carried 6 inches below the bottom of the pipe. Loose earth or gravel shall be used for backfill and tamped thoroughly.
- E. Contractor shall provide and use all bracing, sheathing, and shoring necessary to perform and protect all excavations as shown on the plans, as required for safety, as directed by the Engineer, or to conform to governing laws.
- F. Excavated material shall be stockpiled on the Owner's property and located in such a manner to prevent interference with any traffic, and existing or proposed structures or utilities.
- G. Equipment, materials, trenches, and excavations which may cause a hazard or serve as obstructions to either vehicular or pedestrian traffic, shall be enclosed by fences or barricades, adequately lighted, to protect persons from injury and to avoid property damage.
- H. The Contractor shall furnish temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers, and other obstructions encountered in the process of work.
- I. Where traffic must cross open trenches, the Contractor shall provide suitable bridges, which shall be subject to approval by the Engineer.
- J. All applicable safety requirements of OSHA must be followed.
- K. Trenches shall be properly dewatered prior to placement of the pipe. Where running sand is encountered, well pointing method will be used. If soil conditions prohibit the well pointing method, then french drains of crushed stone or gravel shall be constructed to drain to suitably located sumps and the water removed by bailing or pumping. The Contractor shall provide all labor, materials, tools, and equipment reburied for the dewatering process at no additional cost to the Owner.
- L. Not more than 200 feet of trench shall be opened in advance of pipe laying unless otherwise approved by the Engineer.

- M. Wherever the subgrade is by nature too soft or mucky, in the opinion of the Engineer, for the proper installation of the sewer force main, he may order the Contractor to undercut the trench and backfill with crushed stone or gravel, 3/4" in size and less.
- N. Trenches shall be excavated a sufficient distance in advance of laying the pipe, to prevent the entry of ground water, earth or debris during the construction. The exposed end of all pipes shall be fully protected with a watertight stopper to prevent water, earth, or other substances from entering the pipe during periods when work is not in progress.
- O. The invert profile, as shown on the plans, shall be followed except where changes are authorized in writing by the Engineer to avoid existing structures or to conform to the topography.
- P. The depth of the trench shall be increased where necessary to provide a smoothly curved profile or to avoid existing structures.
- Q. The trench shall be excavated in such a manner as to provide uniform and continuous bearing and support for the pipe, and excavated to the depth required to give a minimum of 36 inches of cover for the pipe from the finished grade to the top outside of the pipe barrel, except under roadways where the minimum cover shall be 30 inches from the subgrade to the top of the pipe barrel and at air release valves where the minimum cover shall be 54 inches from the subgrade to the outside top of the pipe barrel.
- R. The depth of cover may be modified at creek crossings or at other dips in the profile, when approved by the Engineer, provided that the cover is not less than 36 inches for more than one full station (100 feet).
- S. Bell holes shall be provided at each joint to permit the joints to be "made-up" properly.
- T. Where the soil at the bottom of the trench is not uniformly good, and stone, dry clay, hard pan, shale, or cemented gravel is exposed, the trench shall be excavated to at least three inches and not more than six inches below the specified grade, and shall be backfilled to grade with material, approved by the Engineer, containing no rocks, gravel or cinders, in layers not to exceed four inches loose depth. The bedding shall be finished by means of hand tools so as to provide uniform and continuous bearing and support for the pipe.
- U. Where the bottom of the trench at grade is found to be unstable, or includes ashes, cinders, all types of reuse, vegetable or other organic material, the Contractor shall excavate and remove such unsuitable material to the width and depth ordered by the Engineer. The trench shall be backfilled to bedding grade with approved material in four-inch layers to loose depth. Each layer shall be thoroughly compacted to a density specified by the Engineer. The bedding shall be finished by means of hand tools so as to provide a uniform and continuous bearing and support for the pipe. There will be no additional compensation for such excavation and backfill.
- V. Where the bottom of trench grade is found to consist of material which is unstable to such a degree that, in the opinion of the Engineer, it cannot be removed and replaced with material suitable to support the pipe properly, the Contractor shall construct a foundation for the pipe, consisting of concrete, pilings, timber, or other suitable materials, as directed by the Engineer. Special foundations, if not called for on the plans, shall be paid for in accordance with the proposal, or at a price agreed upon by the Owner and Contractor and

approved by the Engineer.

3.10 EXAMINATION

- A. Verify that trench cut and excavation base is ready to receive work, and excavations, dimensions, and elevations are as indicated on Drawings.
- B. Beginning of installation means acceptance of existing conditions.

3.11 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with fill material of fine aggregate.
- B. Remove large stones or other hard matter which could damage drainage tile or impede consistent backfilling or compaction.

3.12 INSTALLATION - PIPE

A. General

1. Install PVC pipe, fittings and accessories in accordance with ANSI/ASTM C151, ANSI/ASTM D2774, latest revisions and manufacturer's instructions. Install ductile iron pipe, fittings and accessories in accordance with AWWA C-600, latest revision and manufacturer's instructions. Seal joints watertight.
2. All pipes and fittings shall be protected during handling against impact shocks and free fall. Pipes and fittings shall be cleaned before they are laid, and shall be kept clean at all times.
3. All pipe and fittings shall be carefully examined for defects and no piece shall be laid which is known to be defective. Before lowering, and while suspended, cast and ductile iron pipe may be gently tapped with a hammer to sound for cracks. Any defective, damaged, or unsound pipe shall be rejected.
4. If any defective piece shall be discovered after having been laid, it shall be removed and replaced with a sound one at the Contractor's expense.
5. The pipe shall be supported its full length by the uniform grade of the trench, and a bell hole shall be dug at each joint, said hole being of sufficient size to ensure the proper "making up" of each joint.
6. Pipe ends shall not be left open such as at the end of a day's work or during temporary suspension of construction, but shall be securely covered to prevent the entry of foreign matter or small animals.
7. Kinks or sharp bends giving excessive deflection or which put pipe joints in strain will not be permitted.

8. Horizontal and vertical curvature, where fittings are not specified, can be obtained by cutting pipe to short lengths. Under no circumstances will pipe at any joint exceed the Manufacturer's recommendations.
9. When cutting short lengths of pipe, a pipe cutter will be used, and care will be taken to make the cut at right angles to the centerline of the pipe. In the case of "push-on" pipe, the cut ends shall be tapered with a portable grinder or coarse file to match the manufactured taper.
10. Where the use of nuts, bolts, washers, rods, straps, and clamps are required due to the peculiarities of the installation, these items shall be installed and be of the size and dimension as shown on the plans. After installation, and before backfilling, all the above items shall be painted with bituminous paint or coal tar enamel. In lieu of the above, accessories and fittings shall be provided using stainless steel or other non-corrosive metals.
11. Any pipe, fitting, or accessory not meeting the specified ASTM Standard shall not be used.
12. Place pipe on approved bedding in accordance with the plans and specifications.
13. Lay pipe to slope gradient noted on Drawings.
14. Pipe lying shall begin at the lowest grade point with spigot ends pointing down grade and forming a uniform invert.
15. Pipe shall not be placed on blocking at any time unless approved by the Engineer, and then only at manholes or other structures where temporary blocking may facilitate installation of the pipe. After the pipe has been installed, all blocking shall be removed and all voids filled with select material and compacted in place.
16. Increase compaction of each successive lift. Do not displace or damage pipe when compacting.

B. "Push-On" Joint Pipe

1. "Push-On" type joints, such as "Ring Tite", "Fastite", or approved equal, shall be prepared by removing all dirt or foreign material from the bell end of the pipe and inserting the gasket.
2. The spigot end of the pipe shall be prepared by cleaning and applying a thin coat of approved lubricant after which the spigot end is centered in the bell and jacked on by using a special jack and choker sling.
3. The procedure in making up this joint shall be performed in accordance with the recommendations of the manufacturer.

C. Mechanical Joint Pipe

1. When "making-up" mechanical joints, the spigot end of each pipe shall be entered into the adjoining bell to within 1/8 inch of the total depth of the bell.
2. The pipe shall be properly centered and have uniform space all around for reception of the packing material.
3. The packing material, bolts, nuts, and other accessories used in making mechanical or sleeve type joints shall be obtained from the manufacturer of the pipe.
4. The surface of the spigot and bell are to be brushed thoroughly with a wire brush just prior to assembling. The spigot end is to be brushed with soapy water just prior to slipping the gasket on and entering it into the bell.
5. When tightening bolts, it is essential that the gland be brought up to the pipe flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. This is to be done by partially tightening the bottom bolt first, then the top bolt, next two bolts at either side, and last, the remaining bolts. Repeat this cycle until all bolts are within the range of the torques listed below:

BOLT SIZE DIA.	RANGE OF TORQUES FT./LBS.
5/8"	40 - 60
3/4"	60 - 90
1"	70 - 100
1-1/4"	90 - 120

If effective sealing is not obtained at the maximum torques indicated above, the joint must be disassembled and reassembled.

D. Flanged Joint Pipe

1. All flanged faces shall be free of all dirt or foreign material. Each face shall be cleaned prior to installing the gasket.
2. Flanges should be inspected to make sure that the flange is true and the bolt holes line up with each other.
3. Flanges should be tightened to the proper torques listed in Section 3.12.C above.

E. Steel Pressure Pipe

1. Steel pressure pipe may be jointed by butt welding, lap welding, or in any other manner recommended by the manufacturer.

3.14 INSPECTION

- A. All work done and materials furnished shall be subject to the inspection of the Engineer.
- B. All improper work shall be reconstructed at the Contractor's expense.
- C. 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 of the rejection of such materials. The rejected materials shall be removed and replaced with approved materials at the Contractor's expense.
- D. The Engineer reserves the right to mark rejected materials to distinguish them as such.

3.15 THRUST BLOCKING

- A. No thrust blocking will be allowed. The pipe sections must be restrained in accordance to Paragraph 3.16.

3.16 RESTRAINED JOINTS AND PIPE

- A. Restrained pipe and fittings shall be installed only in the areas specified on the plans or as directed by the Engineer or as required by the local municipality.
- B. Acceptable methods for joint restraint shall be the use of metal rods or EBAA Iron In., MEGA LUG or approved equal.
- C. Retainers for pipe bells shall be required with the use of the MEGA LUG restraints.

3.17 BACKFILLING

- A. Contractor to backfill in accordance with Section 02200 and the following.
- B. All trenches and excavation shall be backfilled immediately after the pipes are laid therein, unless other protection of the pipeline is directed.
- C. The backfilling materials shall be selected and deposited with special reference to the future safety of the pipes.
- D. Backfill material shall be free from cinders, ashes, refuse, vegetable or other organic materials, boulders, large rocks, or stones. However, from one foot above the top of the pipe to the original ground or to subgrade, material containing stones up to four inches in their greatest dimension may be used, unless otherwise directed by the Engineer.
- E. The backfill material shall be deposited in the trench for its full width in six-inch layers loose depth to the height of one foot above the pipe. Except where special methods of bedding and tamping are provided for, clean earth, sand, or rock dust shall be solidly tamped and compacted as hereinafter described.
- F. Backfilling shall not be done in freezing weather, except by permission of the Engineer, and it shall not be done with frozen material. No backfilling shall be done where the material already in the trench is frozen.

- G. From the bottom of the trench to the centerline of the pipe, the backfill material shall be placed by hand and compacted with approved hand tamps to the required proctor. From the centerline of the pipe, to a height of one foot above the pipe, the backfill shall be placed by hand and compacted by use of approved mechanical tampers to the required proctor. The Contractor shall use special care in placing this portion of the backfill so as to avoid injuring or moving the pipe. The remainder of the backfill in the trench shall be placed by hand or mechanical means in the specified lifts and compacted by the approved mechanical tamper to the specified proctor.
- H. Walking or working on the completed pipe lines, except as may be necessary in tamping or backfilling, shall not be permitted until the trench has been backfilled to a height of at least two feet over the top of the pipe.
- I. After placing the backfill up to a level slightly below the natural ground surface, surplus excavation shall be bermed and maintained in a suitable manner as to concentrate and pond runoff from rains over the trench. After sufficient settlement has been obtained, in the opinion of the Engineer, the Contractor shall complete the dressing, removal of surplus materials, and surface cleanup in accordance with these specifications.
- J. Whenever the trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed of, and finally made to conform to the surface of the ground. Backfilling shall be carefully performed and the original surface restored to the full satisfaction of the Engineer.
- K. Backfill in open trenches across sidewalks and in roadways shall be made as specified above, except that fill above the pipes shall be deposited in layers not to exceed six inches and thoroughly compacted to the specified proctor.
- L. Excess material not needed for backfill, and material unsuitable for backfill, shall be removed from the site and disposed of as directed by the Engineer.
- M. Additional backfill material as required to make up deficiency, or to replace unsuitable excavated material, shall be furnished by the Contractor at no additional cost from approved borrow pits or from excavations on roadways.
- N. The Contractor shall backfill the trench to the original grade or as specified in the plans.
- O. The construction site shall be left in a neat and orderly condition to the Engineer's satisfaction.

3.18 TESTING AND LEAKAGE ALLOWANCE

- A. Leakage is defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water. The allowable limits for leakage of underground piping shall be determined by the following formula.
- B. Each completed section of the pipeline shall be plugged at both ends and slowly filled with water. As the force main is being filled for the hydrostatic pressure test, all air shall be expelled from the pipe through blowoffs, air release valves, or temporary taps.

- C. The force main shall be subjected to a hydrostatic pressure of 150 pounds per square inch for a period of two hours.
- D. The leakage during the test shall not be more than allowed by AWWA C-600-4.
- E. The required hydrostatic pressure shall be applied to the water line by means of a hand pump for small lines or by the use of a gasoline pump or fire engine for larger lines. Water shall be supplied to the line during the test period as required to maintain the test pressure as specified. The quantity used, which shall be compared to the above allowable quantity, shall be measured by pumping from a calibrated container. A 5/8-inch meter installed on the discharge side of the pump may be used to measure the leakage for large mains when approved by the Engineer.
- F. During the test the lines shall be thoroughly examined for leakage at the joints and fixed where applicable.
- G. Any cracked or defective pipes, fittings, or valves discovered in consequence of the pressure test shall be removed and replaced by the Contractor at his own expense. Then the force main is to be retested to the required pressure for two hours.
- H. Where leakage exceeds the allowable limit, as specified herein, the defective pipe or joints shall be located and repaired. If the defective portions cannot be located, the Contractor shall remove and reconstruct as much of the work as necessary in order to conform to the specified limits. No additional payment will be made for the correction of defective work, or to damage to other parts of the work resulting from such corrective work.
- I. In the event that the pipeline is tested in sections and temporary thrust blocking is required, a temporary plug or cap shall be installed and blocked with a screw jack, firmly braced against the end of the trench or against a heavy timber embedded into the sides of the trench.
- J. Where pipeline construction ties into existing lines, and where it is not practicable to make a 2 hour hydrostatic pressure test, the Contractor shall leave this section of pipeline uncovered at each applicable joint for inspection for a period of 48 hours after the connection has been made and the line is placed in service. The Contractor shall make the necessary restraints to make sure that the force main does not blow apart at these uncovered joints. Any leakage discovered in these joints shall be immediately corrected by the Contractor.
- K. All pressure tests must be witnessed for the two hour duration by the Engineer's inspector. The Contractor is to notify the Inspector a minimum of 24 hours prior to the pressure test.
- L. All pressure tests must be witnessed for the two hour duration by the Engineer and/or a qualified Inspector. The Contractor is to notify the Engineer a minimum of 24 hours prior to the pressure test.

LEAKAGE ALLOWANCE TABLE IN U.S. GALLONS
PER 1000 FEET (FOR 50 JOINTS) PER TWO HOURS
(For a 150 psi pressure test)

Pipe Diameter	2"	3"	4"	6"	8"	10"	12"	
Leakage Allowable (DIP)		0.37	0.55	0.74	1.10	1.47	1.84	2.21
Leakage Allowable (PVC)	0.33	0.50	0.66	0.99	1.32	1.66	1.99	

Any other leakage allowance can be obtained by the following formulas:

Ductile Iron:

$$L = [SD(P)^{1/2}] \div 133,200$$

L = allowable leakage (gals./hr)

S = length of the pipeline tested (feet)

D = diameter of pipe (inches)

P = average test pressure (psig)

PVC:

$$L = [ND(P)^{1/2}] \div 7,400$$

L = allowable leakage (gals./hr)

N = # of joints in pipeline being tested

D = diameter of pipe (inches)

P = average test pressure (psig)

3.19 CLEANUP AND MAINTENANCE

- A. Cleanup shall follow immediately behind the pipe laying and backfilling operations. Pipe lines and the construction site shall be kept clean and serviceable until final inspection and acceptance by the Owner.

3.20 FIELD QUALITY CONTROL

- A. Field inspection will be performed by the Engineer.

3.21 PROTECTION

- A. Protect pipe from damage or displacement until backfilling is in progress.

END OF SECTION

SECTION 02650

HORIZONTAL SELF-PRIMING CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.01 PERFORMANCE CRITERIA

- A. The pump manufacturer must be ISO 9001:2008 revision certified, with scope of registration including design control and service after sales activities.
- B. The pump manufacturer must be registered to the ISO 14001 Environmental Management System standard and as such is committed to minimizing the impact of its activities on the environment and promoting environmental sustainability by the use of best management practices, technological advances, promoting environmental awareness and continual improvement.
- C. Pumps must be designed to handle raw, unscreened, domestic sanitary sewage. Pumps shall have 10" suction connection, and 10" discharge connection. Each pump shall be selected to perform under following operating conditions:

1. Pump model	Gorman-Rupp model T10A71S-B
2. Capacity (GPM)	<u>3,000</u>
3. Total Dynamic Head (FT)	<u>65.0'</u>
4. Total Dynamic Suction Lift (FT)	<u>19.08'</u>
5. Maximum Repriming Lift (FT)	<u>16.5'</u>
6. Minimum TDH (FT)	<u>45.0'</u>
7. Maximum TDH (FT)	<u>72.0'</u>
8. Maximum Static Suction Lift (FT)	<u>16.26'</u>
9. Total Discharge Static Head (FT)	<u>13.70'</u>
10. Minimum Submergence Depth (FT)	<u>2.0'</u>

- D. Pumps and VFD Controls shall be coordinated to ensure compatibility between the two.
- E. Pump Performance Certifications
 - 1. Solids Handling Capability
 - a. All internal passages, impeller vanes, and recirculation ports shall pass a 3" 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, manufacturer's certified drawings showing size and location of the recirculation port(s) shall be submitted for approval.
- F. Reprime Performance
 - 1. Consideration shall be given to the sanitary sewage service anticipated, in which debris is expected to lodge between the suction check valve and its seat, resulting in the loss of the pump suction leg, and siphoning of liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal, and the pump must be capable of automatic, unattended operation with an air release line installed.

2. 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.
3. Pump must reprime 16 vertical ft. at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:
 - a. A check valve to be installed downstream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.
 - b. A length of air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.
 - c. The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 2 feet minimum horizontal run, a 90° elbow and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.
 - d. Impeller clearances shall be set as recommended in the pump service manual.
 - e. Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
 - f. Liquid to be used for reprime test shall be water.
 - g. Upon request from the engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

G. Certified Pump Performance Test

1. Tests shall be conducted in accordance with Hydraulic Institute Standards 14.6.3.4 Acceptance Grade 2B at the specified head, capacity, rated speed and horsepower. The performance tests will validate the correct performance of the equipment at the design head, capacity and speed.

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 sixty (60) months, 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 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.
4. It is not intended that the pump manufacturer assume liability for consequential damages or contingent liabilities arising from failure of any vendor supplied product or part which fails to properly operate, however caused. Consequential damages resulting from defects in design, or delays in delivery are also beyond the manufacturer's scope of liability.
5. This limited warranty shall be valid only when installation is made and use and maintenance is performed in accordance with manufacturer recommendations. The warranty shall become effective on the date of acceptance by the purchaser or the purchaser's authorized agent, or sixty (60) days after installation, or ninety (90) days after shipment from the factory, whichever occurs first.

PART 2 - PRODUCT

2.01 MANUFACTURER

- A. The specifications and project drawings depict equipment and materials manufactured by The Gorman-Rupp Company which are deemed most suitable for the service anticipated. The contractor shall prepare his bid based on the specified equipment for purposes of determining low bid. Award of a contract shall constitute an obligation to furnish the specified equipment and materials.
- B. Upon request of the Engineer, manufacturer shall provide an installation list consisting of 20 current users of manufacturer's equipment in South Carolina and 100 in the United States.
- C. Pumps shall be of standard catalog design, totally warranted by the pump manufacturer.
- D. Upon request of the Engineer, manufacturer must show proof of original design and testing. "Reverse engineered" products fabricated to substantially duplicate the design of the original product shall not be allowed, as they may contain substantial differences in tolerances and material applications addressed in the original design which may contribute to product failure.
- E. For quality control reasons pumps shall be cast, machined, assembled, and tested in the United States.

2.02 PUMP DESIGN

- A. Pumps shall be horizontal, self-priming centrifugal type, designed specifically for handling raw, unscreened, domestic sanitary sewage. Pump solids handling capability and performance criteria shall be in accordance with requirements listed under PART 1 - GENERAL of this section.
- B. The pump manufacturer must be ISO 9001:2008 revision certified, with scope of registration including design control and service after sales activities.
- C. Materials and Construction Features
 1. Pump 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 coverplate, 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.
 - d. Liquid volume and recirculation port design shall be consistent with performance criteria listed under PART 1 - GENERAL of this section.
- D. The pump must be equipped with a removable suction head and clean-out cover plate, allowing access for service and repairs without removing suction or discharge piping. The suction head shall be removable and incorporate a Victaulic connection. The suction head clean-out cover shall permit the removal and replacement of the suction flap valve. The pump shall be provided with a replaceable suction check valve assembly including a flap valve and cast iron flap valve seat.

The pump shall be fitted with replaceable front and rear wear plates. The front wear plate shall be austempered ductile iron with Brinnell hardness 400 minimum. Replacement of the front wear plate, impeller, seal, and suction check valve shall be accomplished through the removable suction head. The entire rotating assembly, which includes bearings, shaft, seal, and impeller, shall be removable as a unit, through the front or rear of the pump, without removing the pump volute or piping.

- E. Each pump shall incorporate a suction flap valve that can be removed or installed through the removable clean-out cover plate opening, without disturbing the suction piping. Sole function of check valve shall be to eliminate re-priming with each cycle. Pumps requiring suction check valves to prime or re-prime will not be acceptable.
- 1. In consideration for safety, a pressure relief valve shall be supplied in the suction head. Relief valve shall open at 75-200 PSI.
 - 2. Rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing, must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:
 - a. Seal plate shall be constructed of Austempered ductile iron(ADI) 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. 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. 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.
 - b. Double lip seal shall provide an atmospheric path providing positive protection of bearings, with capability for external drainage monitoring.
 - c. Impeller shall be austempered 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 lock screw and conical washer.
 - d. Shaft shall be AISI 4140 alloy steel unless otherwise specified by the engineer, in which case AISI 17-4 pH stainless steel shall be supplied.
 - e. 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.
- f. Shaft seal shall be cartridge oil lubricated mechanical type. The stationary and rotating seal faces shall be tungsten titanium 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 seal plate, 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 stainless steel. Seal shall be oil lubricated from a dedicated reservoir. The same oil shall not lubricate both shaft seal and shaft bearings. Seal shall be warranted in accordance with requirements listed under PART 1 - GENERAL of this section.
 - g. Pusher bolt capability to assist in removal of rotating assembly. Pusher bolt threaded holes shall be sized to accept same hardware as used for retaining rotating assembly.
3. Adjustment of the impeller face clearance (distance between impeller and wearplate) shall be accomplished by external means.
 - a. Clearance adjustment which requires movement of the shaft only, thereby adversely affecting seal working length or impeller back clearance, shall not be acceptable.
 4. 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 cleanout opening on suction head, 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.
 5. Spool flanges shall be one-piece cast iron, class 30 fitted to suction and/or discharge ports. 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.

2.03 SERVICEABILITY

1. The pump manufacturer shall demonstrate to the engineer's satisfaction that consideration has been given to reducing maintenance costs.
2. No special tools shall be required for replacement of any components within the pump.

2.04 PUMP BASE

1. The pump unit(s) shall be mounted on an individual, vertical v-belt base. The base shall comprise a base plate, perimeter flange, and reinforcements. Base plate shall be fabricated of steel not less than 1/4" thick. Flange and reinforcements shall be designed to prevent flexing or warping under operating conditions. Base plate and/or flange shall be drilled for hardware used to secure unit base to concrete pad as shown on the contract drawings. The base shall contain provisions for lifting the complete pump unit during shipping and installation.
2. The pump shall be provided with a N.O. thermostat, which shall cause the pump to be disconnected in the event of a high pump temperature condition. A high pump temperature protection circuit shall override the level control and shut down the pump motor(s) when required to protect the pump from excessive temperature. A thermostat shall be mounted on

each pump casing. If casing temperature rises to a level sufficient to cause pump damage, the high pump temperature protection circuit shall interrupt power to the pump motor. The pump motor shall remain locked out until the pump has cooled and circuit has been manually reset. Automatic reset of this circuit is not acceptable.

3. Pump motors shall be Baldor ECP-series, 100 HP, 3 phase, 60 hertz, 460 VAC, horizontal TEFC, 1,800 RPM, NEMA design B with cast iron frame with copper windings, induction type, inverter duty with Class F insulation and 1.15 service factor for normal starting torque and low starting current characteristics, suitable for continuous service.
4. Motors shall be outfitted with shaft grounding ring.
5. The motors shall not overload at the design condition or at any head in the operating range as specified. Motors shall be tested in accordance with provisions of ANSI/IEEE Standard 112.
6. Power to pumps shall be transmitted by V-belt drive assemblies. The sheave/belt combination shall provide the speed ratio needed to achieve the specified pump operating conditions. Each drive assembly shall utilize at least two V-belts providing minimum a combined safety factor of 1.5. Single belt drives or systems with a safety factor of less than 1.5 are not acceptable. Computation of safety factors shall be based on performance data published by the drive manufacturer. Pump drives to be enclosed on all sides by a guard constructed of fabricated steel or combination of materials including expanded, perforated, or solid sheet metal. No opening to a rotating member shall exceed 1/2 inch. Guards must be completely removal without interference from any unit component, and shall be securely fastened and braced to the unit base. The guard shall be finished in accordance with Section 3, Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.

2.05 FIELD QUALITY CONTROL

Operational Test

1. 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.
2. After construction debris and foreign material has been removed from the wet well, contractor shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and liquid level controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration or other operational problems.

END OF SECTION

SECTION 02770

ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Power, lighting and control system.
- B. Installing and connecting starting equipment and controls for pumps and pumping equipment and other specified items.
- C. Feeders and branch circuits for, and electrical connections to pumping, metering, signaling and mechanical equipment.
- D. Power, lighting and control system for pump station equipment.
- E. Other electrical items as may be necessary to complete the work shown in the plans.

1.02 RELATED SECTIONS

- A. Section 02650 - Horizontal Self-Priming Centrifugal Pumps.
- B. Section 016300 - Sewage Electrical VFD Control Panel.

1.03 REFERENCES

- A. National Electrical Code, latest edition

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the work of this section.

1.05 SUBMITTALS

- A. Submit all product data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. General Electric
- B. Westinghouse
- C. Square D

D. Substitutions: Under provisions of Section 01600.

2.02 GENERAL

- A. These specifications shall apply to the materials to be furnished and installed to complete the electrical portions of the plans.
- B. All electrical wires, fittings, and accessories shall be of the type and class shown on the plans or designated in these specifications or as required by applicable code.
- C. All materials shall be new and shall conform to the standards of Underwriter's Laboratories, Inc. in every case where such a standard has been established for the particular type of material in question.

PART 3 INSTALLATION

3.01 CODES, PERMITS, AND INSPECTIONS

- A. The Contractor shall obtain, at his own expense, all necessary permits required for the proper execution of the work covered by this section of the Specifications. Further, he shall comply with the regulations of the National Electrical Code and all local codes having jurisdiction and shall deliver to the Owner, without charge, all certificates of inspection issued by inspecting authorities. The Contractor shall familiarize himself with all local codes having jurisdiction before submitting bids.

3.02 STANDARDS FOR WORKMANSHIP

- A. All work shall be executed in a workmanlike manner and shall present a neat and mechanical appearance when complete.

3.03 CHANGES AND ADDITIONAL WORK

- A. No change shall be made from the work as called for by these Specifications and Drawings except on the written order of the Engineer. No charges for extra work shall be allowed unless such extra work has been authorized by a written order of the Engineer stating charge to be made for the work.

3.04 MATERIAL AND EQUIPMENT SCHEDULES

- A. As soon as practical and within 30 days after the date of award of Contract, and before any purchase of material is made, the Contractor shall submit to the Engineer for approval a complete list in triplicate of materials, fixtures, and equipment to be incorporated in the work. The list shall include catalog numbers, cuts, diagrams, drawings and such other descriptive data as may be required by the Engineer. No consideration will be given to partial lists submitted from time to time.

3.05 EQUIPMENT ENCLOSURES

- A. Unless specifically specified otherwise, equipment enclosures covered in paragraphs following in this Section of the Specifications pertain to equipment that is intended for use above grade and in normally dry locations. Electrical characteristics of all equipment and devices shall comply with the application provisions of other paragraphs of this section of the Specifications.
- B. All equipment except as otherwise indicated shall be contained in a NEMA 1, 14-gage steel welded cabinet with fixed panel for all components, in control buildings or NEMA 3R, mounted on poles outside. Double front access doors shall have key, lock and handle. Junction and outlet boxes shall be of the cast-metal type with arrangements of the National Electrical Code.

3.06 ELECTRICAL SERVICE

- A. **VOLTAGE:** The service voltage for the control building shall be 480 volts, 3-phase for operating four (4) 100hp pumps equipment. A transformer 15KVa shall be installed for house lighting and all 120 volt power with a separate lighting panel.
- B. **UTILITY COORDINATION AND CONNECTION:** The Contractor is responsible for coordinating with the local utility in bringing service to all required sites. The Contractor is responsible for making all electrical connections required for the job. Metering shall be the requirements with the local utility to assure that the meter socket is located to suit and that conduit and wire are installed from the meter socket to the current transformers. Service conductors in rigid meter conduit terminating with a service mast including flashing and fitting shall be furnished and installed. Whenever possible all exterior wiring will be enclosed in underground conduit.

3.07 CONDUIT SYSTEM

- A. Conduit system shall be installed in accordance with the applicable provisions of the National Electrical Code. Conduit shall be galvanized rigid steel. Exposed runs of conduit shall have supports spaced not more than 8 feet apart and shall be installed with runs parallel or perpendicular to walls or structural members with right angle turns consisting of cast metal fittings or symmetrical bends. Conduit which has been crushed or deformed in any way shall not be installed. Conduit shall be securely fastened to all metal outlet junctions and wiring troughs with galvanized locknuts and bushings. Equipment connections shall be made with flexible or rigid conduit as required, except that connections to equipment in outdoor installations shall be made with watertight plastic covered flexible conduit. All conduit shall be painted with an asphaltic paint or corrosive resistant.

3.08 CONDUCTORS

- A. A complete system of conductors shall be installed in the raceway system. Branch circuit and feeder connectors within the building shall be Type THW. Branch circuit wiring shall be no smaller than Number 12 AWG. Control wiring shall be no smaller than Number 14 AWG. Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized

where required.

- B. Service conductors shall be Type THW installed in conduit routed and sized as shown on the Plans. Underground feeders shall be Type THW installed in plastic coated rigid conduit as shown on the Plans.

3.09 OUTLETS, COVER PLATES AND PULL BOXES

- A. Outlet boxes of a type to suit the intended use shall be installed at the location shown on the Plans. In general, wall receptacles shall be 36 inches above the floor and wall switches four feet above the floor. Switch, receptacle and other wall mounted boxes shall be four inches square fitted with appropriate plastic covers or may be deep switch boxes with mounting ears designed for concrete block or tile construction. Outlets for exposed work shall be of cast steel or allow fitted with appropriate covers.
- B. Cover plates for all switch and receptacle shall be oversized, satin finish, stainless steel or aluminum plates as made by Sianor, Sierra, or an approved equal.
- C. Pull boxes and wiring troughs, where required for interior work, shall be constructed of code-gage galvanized sheet metal of not less than the minimum size recommended by the National Electric Code. Boxes shall have screw fastened covers. Pull or junction boxes exposed to the weather shall be watertight and shall be made of cast metal. A suitable gasket shall be installed between the box and cover and a sufficient number of cover screws shall be installed to hold the cover firmly in place along its entire contact surface. Where several circuits pass through a common pull box, the circuits shall be tagged to indicate clearly their electrical characteristics, circuit number and designation.

3.10 RECEPTACLES

- A. All interior duplex convenience receptacles shall be specification grade, rate 15 amperes, 125 volts, Hubbell Number 5252, or equal, and single receptacles, Hubbell Number 521, or equal. Exterior convenience receptacles shall be weather-proof, Hubbell Number 5214, or equal.

3.11 MOTOR STARTER

- A. In general, all motor starters, control for all motor operated equipment, metering equipment, and pumping equipment are to be furnished under other sections of the Specifications, but installed and wired under this section. Starter shall be equal to those manufactured by Square "D" Company only.
- B. An aluminum nameplate with black background and etched natural aluminum letters shall be furnished on each starter and breaker to designate the circuit.

3.12 CONTROL AND CONTROL WIRING

- A. All power and control wiring and the installation and adjustment of electrical apparatus shall be accomplished by the Electrical Subcontractor.

3.13 GROUNDING

- A. The neutral conductor and equipment grounding shall be in accordance with applicable sections of the National Electrical Code.

3.14 TESTS

- A. After the entire electrical system is completed, and at such time as the Engineer may direct, the contractor shall conduct an operating test for approval. The tests shall be performed in the presence of the Engineer or his authorized representative, and the equipment shall be of these Specifications. The Contractor shall furnish all equipment and personnel required for the tests.

3.15 GUARANTEE

- A. The Contractor shall leave the entire electrical system installed under this contract in proper working order and shall, without additional charge, replace any work or material which develops defects, except from ordinary wear and tear, within one year from the date of the final acceptance by the Owner.

3.16 PAYMENT

- A. Payment for all items included in this section shall be included in the lump sum price for "Electrical" as set forth in the Proposal.

END OF SECTION

SECTION 02780

EMERGENCY GENERATOR

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diesel powered emergency generator in connection with well pumps, booster pump stations and sewer lift stations.
- B. Auxiliary equipment.

1.02 RELATED SECTIONS

- A. Section 02770 – Electrical.

1.03 REFERENCES

- A. NFPA 76
- B. UL-1008

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the work of this section.

1.05 SUBMITTALS

- A. Submit all data for the diesel powered generator and auxiliary equipment.
- B. Submit foundation plan design.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Substitutions: In accordance with Section 01631.

2.02 GENERAL

- A. These specifications shall apply to the materials to be furnished and installed to complete the emergency generator installation in accordance with the plans.
- B. All equipment and auxiliaries shall be of the class and type as indicated on the plans or as designated here within.
- C. The equipment specified herein and all required auxiliary equipment, fittings, shall be furnished to make a complete installation.

2.03 EMERGENCY GENERATOR

- A. The standby electric power system shall include an electric generating set rated for standby service at Chestnut Road Pump Station. The complete, operable standby system; factory tested ready for installation, shall be a package of new and current equipment by Caterpillar or approved equal, consisting of the following:
1. Engine driven electric generating set to provide standby power.
 2. An engine-generator control console mounted on the generating set shall include complete engine start-stop control and monitoring systems. Controller to be equipped with vibration isolation pads.
 3. An automatic transfer switch to initiate automatic starting and stopping of the engine and switching of the load.
 4. Mounted accessories and other equipment as specified.
 5. Generator shall run 24 hours.
- B. The system shall be built, tested and shipped by a manufacturer, who has been regularly engaged in the production of the engine-generator sets and associated controls for a minimum of ten years, so there is one source of supply and responsibility. Local manufacturers' service and parts must be available 24 hours per day and located within 75 miles of the installation. Surrogate service is unacceptable.
- C. The manufacturer shall furnish schematic and wiring diagrams for the engine-generator set, automatic transfer switch and an interconnecting diagram shown connection to individual components which constitute the standby power system. Performance tests of the generating set series shall be certified by an independent testing laboratory.
- D. The complete standby electric power system shall be warranted for a period of five years from start-up or 2500 operating hours, whichever occurs first. In addition to the manufacturer's warranty, the local service representative shall have in operation, and for a period of two years from start-up, schedule a preventive maintenance inspection to be performed quarterly at no charge to the owner and must be signed off in a permanent log to be supplied by the representative and maintained on the engine-generator equipment at all times. Included in the inspection will be a review of all operating and maintenance requirements with the owner.
- E. The approved bidders shall furnish with their bids the following information along with certification as to approval.
1. Make of engine
 2. Number of cylinders
 3. Bore, inches
 4. Stroke, inches
 5. Piston displacements, cubic inches
 6. Piston speed, feet per minute at rated RPM
 7. BMEP at rated KW output
 8. Make and type of generator

9. Generator electrical rating, KVA
10. Number of type of bearings (generator)
11. Exciter type
12. State if turbo-charged and after-cooled or both
13. H.P. Continuous
14. H.P. Standby
15. Maximum SKVA available
16. Temperature rise at full load
17. Charger

- F. Exceptions to these specifications may be considered sufficient cause for rejection of bids.

2.04 DIESEL ENGINE

- A. Type: The engine shall be a compression ignition engine of Domestic Manufacture only. No foreign engines allowed. It shall be a 60 cycle solid-injection engine of either vertical in-line or V-type provided sufficient continuous/standby and continuous H.P. is developed as called for herein.
- B. Horsepower rating shall be rated continuous. Engine manufacturer's published curves both standby and continuous shall be submitted. Set shall be capable of continuous operation for a minimum of 30 days without damage at the standby rating. Continuous rating shall be capable of 10% overload for 2 hours of any 24 and shall be the same at the standard continuous industrial engine rating. Special ratings will not be allowed. All ratings shall be substantiated by factory published curves. Engine BHP shall be 1.5 x rate KW. Maximum BMEP shall not exceed 174 PSI.
- C. Speed: The engine speed shall not exceed 1800 RPM normal full load operation. Use of speed reducers/increasers, gear drives and belts are prohibited.
- D. Fuel: The engine shall be capable of satisfactory performance on a commercial grade of distilled petroleum fuel oil such as No. 2 fuel oil.
- E. Isochronous Governor: The engine speed shall be governed by an (electric, hydraulic) governor to maintain governed speed at precise isochronous control for 60 cycle operation. The frequency at any constant load, including no load, shall remain within a steady state band width of plus or minus (.25% - 3%) of rated frequency. The governor shall not permit frequency modulation (defined as the number of times per second that the frequency varies from the average frequency in cyclic manner) to exceed 60 cycle per second. Governor and controller shall be equipped with single phase load pulse option for quicker response.
- F. Fuel System: The fuel system shall be that which is normally used by the diesel engine manufacturer. It shall include a replaceable element fuel filter conveniently located for servicing. The fuel tank shall have a capacity sufficient to permit the engine to run for twenty-four (24) hours at full rated load without refueling. The fuel tank must be labeled as to contents. The fuel tank must be a double walled tank or have a suitable fuel containment system built around the storage tank. A fuel containment system must be designed to contain the entire volume of the fuel tank plus seven inches of rainwater volume over the entire containment system area. Fuel lines will be double walled. It shall be contained in a rupture basin with 110% capacity. The tank shall meet UL142

standards. A locking fill cap, a mechanical reading fuel level gauge, low fuel level alarm contact, and fuel tank rupture alarm contact shall be provided.

5 Gallon Fuel Fill spill containment (without exception)

- G. Oil Pump and Cleaners: The engine shall have a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank-pin bearings, piston pins, timing gears, camshaft bearings and valve rocker mechanism.

Full flow filters, conveniently located for servicing, shall be provided. Filters shall be equipped with a spring bypass valve to insure oil circulation if filters are clogged.

- H. Cylinder Liners: The engine shall be provided with removable wet or dry type cylinder liners of close-grained alloy iron.

- I. Air Cleaners: The engine shall be provided with one or more dry type air cleaners, as recommended by the engine manufacturer.

- J. Starting: The engine shall be equipped with a (12, 24) volt electric starting system with sufficient capacity to provide cranking of the engine at a speed which will allow diesel starting of the engine.

1. Batteries: (Lead Acid, Calcium, Nicad) Battery. Batteries shall be rack mounted with the appropriate number of cells for engine manufacturer system voltage.

Capacity shall be for at least 3 cranking cycle (each cycle consisting of 3 each 10-second cranks with 5-second rest at 60 degrees F.

2. Battery Charging: An automatic "float" type battery charger shall be provided to maintain the batteries at normal capacity and to recharge batteries after cranking. The charger shall be 120 volts input with (12, 24) volt output. It shall include AC compensation, current limit, DC ammeter, volt-meter to show battery voltage, equalizing switch, fused AC input and DC output, complete isolation of AC input and DC output and be designed as not to discharge battery in a maximum of 8 hours. The charger shall bear Underwriters Lab Label. Charger shall be on circuit fed by emergency system.

- K. Engine Instruments: The engine mounted instrument panel shall contain the following gauges for proper engine surveillance and maintenance:

1. Engine Water Temperature
2. Engine Lube Oil Pressure
3. Engine Running Hourmeter
4. Engine Lube Oil Temp. (outside units only)

- L. Cooling: Cooling shall be by means of a skid mounted radiator. The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when the diesel generator set is delivering full-rated load at the ambient temperature and sized for a minimum of 110 degrees F. ambient regardless of stated ambient.

The engine shall be equipped with an engine driven, water circulating pump if required and thermostatic valve to maintain the engine at a recommended temperature level.

System shall be filled with a suitable coolant. Heat rejection data on the engine and cooling capacity of the standpipe shall be submitted showing calculations and capacities.

The engine generator shall be supplied with a block heater capable of keeping the engine at operating temperature during cold weather to insure quick starting. The heater shall be 120 volts and sized to match engine displacement.

- M. Exhaust System: A super critical grade silencer, companion flanges, and flexible stainless steel exhaust fitting properly sized shall be furnished and installed inside enclosure (no exception). The silencer shall be mounted so that its weight is not supported by the engine nor will exhaust system growth due to thermal expansion be imposed on the engine. Exhaust pipe size shall be sufficient to ensure that exhaust backpressure does not exceed the maximum limitations specified by the engine manufacturer.
- N. Safety Controls: The engine shall be equipped with automotive safety controls which will shut down the engine in the event of low oil pressure, overcrank, high water temperature and engine overspeed and make electrical contacts for alarm lights on the control panel.
- O. Mounting: The engine and generator shall be equipped with suitable sub-base for mounting the engine-generator unit on a concrete foundation or a suitable steel base.

The engine shall be equipped with spring type vibration isolators between the sub-base and the concrete foundation. Isolators shall have adjustable snubbers.

The complete assembly shall be suitable for outdoor mounting complete with epoxy painted steel weather proof or fiberglass weatherproof housing complete with required louvers. All hardware shall be stainless steel and housings are to be equipped with locks and roof mounted exhaust systems.

2.05 ALTERNATOR

- A. Rating: The generator shall be a 480 volt, 3 phase, 4 wire, rate 400 KW by resistance over an ambient of 40 degrees C, continuous duty.
- B. Construction and Manufacture: The generator shall be a salient pole synchronous alternator, continuous rated, 0.8 P.F., 120 KVA. The unit shall be the single bearing type with disc type coupling rigidly bolted to the generator shaft. The generator rotating speed shall not exceed 1800 revolutions per minute as specified.
- C. Rotating Exciter: The generator shall be of brushless construction using a full wave three phase rotating rectifier assembly with hermetically sealed, metallic type silicon diodes to supply main field excitation. The rotating exciter shall be mounted outboard of the generator bearing to allow removal of all or any part of the exciter without disassembly of the generator. It shall be possible to check the rotating diodes without breaking any solder connection. A multi-plate selenium surge protector shall be connected across the rotating diode network to protect it against transient conditions.

The exciter shall be capable of maintaining 300% short circuit current on the alternator and provide full exciter power regardless of alternator voltage for motor starting and sustaining voltage for sufficient time for protective devices to operate.

The generator-exciter regulator package shall provide a voltage regulation of plus or minus 1% of rated voltage. Voltage regulation shall apply to any load from no load to rated load at rated power factor. The regulator system shall include a power isolation transformer, under frequency protection and auto-manual controls.

Stator insulation shall be Class "F", epoxy-vacuum impregnated, rated for 30 degrees C rise by resistance above a 40 degree C ambient, continuous duty.

With the generator operating at rated speed, rated voltage, no load, the sudden application of rated load, rated power factor shall not cause a transient voltage deviation of more than 18% from rated voltage.

Armortisseur windings with the end plates connected between poles shall be included for minimizing harmonic content, good transient performance.

The generator shall be equipped with an adequately sized conduit box for making external connections.

2.06 CONTROL EQUIPMENT AND ACCESSORIES

- A. The engine generator instrument panel shall be wired, tested and shock mounted on the generating set. It shall contain but not be limited to the following: Panel lights, manual reset field circuit breaker, frequency meter, running time meter, voltage adjusting rheostat, 3 ½ - 2% accuracy AC voltmeter and ammeter, meter switch, voltmeter-ammeter selection with off position, oil pressure gauge, coolant temperature gauge if applicable, and battery charging rate ammeter, 4 position selector switch; Off, Auto, Test, Hand-crank, and the following safety shut-downs: high engine temperature, overcrank, low oil pressure, low coolant level and overspeed with signal lights and alarm terminal shall be provided. Optional wall mounted or free standing cabinet acceptable.
 - 1. A 4 pole, 225 amp line circuit breaker shall be mounted in alternator outlet box or NEMA I enclosure. Field circuit breaker will not be considered as line C.B.
- B. Automatic Controls
 - 1. Automatic Start-Stop System: The engine starting panel shall automatically provide four cranking and three rest periods, and shall also be energized if the engine has not started by the end of the fourth cranking cycle. In addition, an audible alarm, energized by the automatic starting panel or safety controls shall be provided. Operation shall be initiated by the closing of contacts in the automatic transfer switch. The automatic starting panel control switch shall include the positions of "Automatic", "Off", and "Manual". The automatic starting panel shall contain 120 volt alarm lights energized by the safety controls noted.
- C. Remote Annunciator: The generator system shall include a 9 indicator remote annunciator panel complying with NFPA bulletin #76 for audible and visual signals and shall be located as shown on the drawings. Engine shall be equipped with pre-alarms for all conditions required under NFPA 76.

2.07 AUTOMATIC TRANSFER SWITCH (Must be supplied in the generator package to insure proper coordination and one source of responsibility.)

- A. Rating: The automatic transfer switch shall be furnished as shown on the drawings with full load current rating of 600 amperes at 480 volts, 3 phase, 4 wire, and 60 hertz. The transfer switch shall be capable of switching all classes of load and shall be rated for continuous duty when installed in a non-ventilated enclosure constructed in accordance with Underwriters Laboratories, Inc. Standard UL-508.
- B. Construction and Performance: The transfer switch shall be double throw, actuated by a single electrical operator momentarily energized. The transfer switch shall be capable of transferring successfully in either direction with 70% or rated voltage applied to the switch terminals. Transfer switch shall have a set of dry contacts for remote annunciation of transfer.

The normal and emergency load contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing.

The transfer switch shall be equipped with a manual operator that is designed to prevent injury to the operating personnel if the electrical operator should suddenly become energized during manual transfer. The manual operator shall provide the same contact transfer speed as the electrical operator to prevent a flashover from switching the main contacts slowly. A manual operator designed only for maintenance purposes and not capable of full load, energized operation will not be allowed.

- C. Sequence of Operation: Engine starting contact shall be provided to start the generating plant if any phase of the normal source drops below 70% of rated voltage after a non-adjustable time delay period of 3 seconds, to allow for momentary dips. Voltage monitoring of all three phases is required. The transfer switch shall transfer to emergency as soon as the voltage and frequency have reached 90% of rated. After restoration of normal power on all phases to 90% of rated voltage, an adjustable time delay retransfer to normal power until it has had time to stabilize. If the emergency power sources shall fail during the time delay period, the time delay shall be by-passed, and the switch has retransferred to normal, the engine-generator shall be allowed to operate at no load for an adjustable period of time (0-5 minutes) to allow it to cool before shutdown. The transfer switch lights on the cabinet door to indicate the switch closed on normal or emergency and four auxiliary contacts on the main shaft; two closed on normal, two closed on emergency. In addition, one set of relay contacts shall be provided to open upon loss of the normal power supply. All relays, timers, control wiring and accessories to be front accessible. The automatic transfer switch shall contain an automatic exerciser 15 minutes once every 168 hours under load.

For proper system coordination, the manufacturer of the automatic transfer switch shall verify that his switch is listed by Underwriters Laboratories, Inc., in his submittal, under UL-1008 with a withstand and closing rating at least equal to the interrupting rating of the circuit breaker specified by the engineer to protect the circuit. Available fault current is 600 amps RMS symmetrical.

PART 3 INSTALLATION

3.01 GENERAL

- A. The Contractor shall furnish all material and labor, and construct the emergency generator shown on the plans, including all foundations, enclosures, mounting hardware, electrical wiring, locks, fuel tanks, and other auxiliary equipment that may be required to furnish a complete installation.
- B. The Contractor shall be responsible for clearing all debris, rubbish, tools and equipment from the site and restoring the site to a neat and orderly appearance.

3.02 FOUNDATION

- A. The foundation shall be of reinforced concrete and of dimensions suitable for the equipment to be installed thereupon.
- B. Anchor bolts shall be of a type approved by the equipment manufacturer(s) and shall be stainless steel.
- C. The top of the foundation shall be at least three inches above the surrounding earth to prevent water from entering the equipment area.
- D. Suitable openings shall be placed in the foundation for all electrical wiring which must pass through it. Electrical wiring to the facility being serviced shall pass through conduit meeting standards of the National Electric Code, latest edition.

3.03 TESTING

- A. Before the equipment is installed, a dealer certified test log of the generator set showing a minimum of 4 hours testing with 2 hours of 100 percent rated load, continuously, shall be submitted to the A.E. Normal preliminary engine and generator tests shall have been performed before unit assembly and shall include transfer switch and simulated loss of power.

Prior to acceptance of the installation, the equipment shall be subjected to a full load test. Contractor shall provide load banks and operator for this test if building load is insufficient or unavailable.

END OF SECTION

SECTION 02790

BUILDING CONSTRUCTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Building construction Water Booster pump station.

1.02 RELATED SECTIONS

- A. Section 02791 - Roofing Underlayment, High-Temperature.
- B. Section 03250 - Concrete.

1.03 REFERENCES

- A. ALSC = American Lumber Standards Committee: Softwood Lumber Standards.
- B. APA - American Plywood Association.
- C. AWPA - American Wood Preservers' Association: Book of Standards.
- D. FS - TT-W-571 - Wood Preservation: Treating Practices.
- E. NFPA - National Forest Products Association.
- F. SFPA - Southern Forest Products Association.
- G. ANSI/ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- H. ANSI/ASTM D226 - Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
- I. ANSI/ASTM B221 - Aluminum-Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
- J. ANSI/ASTM E283 - Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors.
- K. ANSI/ASTM E330 - Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- L. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
- M. FS JTT-P-31 - Paint, Oil: Iron-oxide, Ready Mixed, Red and Brown.
- N. FS TT-P-645 - Primer, Paint, Zinc Chromate, Alkyd Type.

1.04 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the work of this section.

1.05 SUBMITTALS

- A. Submit all product data.
- B. Submit product data for doors, paints, coatings and roofing materials.

PART 2 PRODUCTS

2.01 GENERAL

- A. These specifications shall apply to the materials to be furnished and installed to complete the building construction in accordance with the plans.
- B. All materials shall be of the class and type as indicated on the plans or as specified here within.

2.02 MASONRY MATERIALS

A. Mortar Materials

1. Portland Cement shall conform to A.S.T.M. Spec. C-150, Type 1, latest edition.
2. Hydrated Lime shall meet A.S.T.M. Spec. C-207, Type S, latest edition.
3. Sand shall be clean, sharp and well graded from coarse to fine.
4. Masonry cement may be a standard package product acceptable to the Engineer and shall conform to A.S.T.M. Spec. C-91, Type II.
5. Water for all work shall be free of organic material, strong acids, or alkalis.

B. Steel Reinforcing

1. Steel bars for core and lintel reinforcing shall conform to A.S.T.M. Spec. A-15.
2. Masonry wall reinforcing shall be truss design, galvanized, standard weight, DUR-O-WALL conforming to A.S.T.M. Spec. A-153, Class B-2.

2.03 DOORS

A. Entrance Doors and Frames

1. Exterior entrance doors shall be 3.0 Bi-hinge Therma-Tru Model (FC100) out swing type door. Doors shall be placed in metal frames. Doors shall be painted the color selected by the owner.
2. All door hardware to be stainless steel.

2.04 SUBMITTALS

- A. Submit shop drawings and product data.
- B. Include wall opening and component dimensions; wall opening tolerances required; anchorage and fasteners; affected related work; installation requirements.
- C. Submit manufacturer's installation instructions.

2.05 WOOD FRAME AND ROOF

A. Framing and Sheathing

- 1. Lumber Materials: All Joists, Rafters, Girders, Trusses, Beams, Studs, and other Structural Wood Members shall be No. 2 kiln-dried Southern Yellow Pine Treated Lumber or Better (Fb = 1300 psi, FT = 675 psi, Fc = 1200 psi).
- 2. Plywood Materials: Roof Sheathing - APS Structural I, Grade CC-EXT-APA; unsanded. 5/8" Thick, attached with 8d Galvanized nails 4" o.c.
- 3. Accessories: Fasteners - Hot dipped galvanized steel for exterior, high humidity, and treated wood locations; plain finish elsewhere; size and type to suit condition.
- 4. Wood Treatment: Wood Preservative (Pressure Treatment) - FS TT-W-571 AWP Treatment C@ using waterborne preservative with 0.30 percent retainage.

Wood Preservative (Surface Application): Clear type.

B. Roofing Materials

- 1. Steel Roofing: 29 gauge metal roofing; 40 year limiting paint warranty; Light Gray.
- 2. Underlayment: See Section 02791.
- 3. Fasteners: Manufacturer standard #12 by 1 ¼ inch long self-drilling, hex head drive screws for metal non-corrosive base material color to match roof color.
- 4. Plastic Cement: ANSI/ASTM D2822; asphaltic type with mineral components.

C. Flashing Materials

- 1. Sheet Flashings (Drip Edge): ANSI/ASTM B209; 0.03 inch thick aluminum.
- 2. Nails: Standard round wire roofing type of hot-dipped zinc-coated steel; minimum 19/64 inch head diameter and 0.104 inch shank diameter; of sufficient length to penetrate through roof sheathing.

PART 3 INSTALLATION

3.01 GENERAL

- A. The Contractor shall furnish all material and labor, and construct the buildings shown on the plans, including all clearing, grubbing, excavating, sheathing, backfilling, and other appurtenances, as shown on the plans.
- B. The Contractor shall be responsible for the cleaning away of all rubbish, surplus materials, and the furnishing of all materials, tools, implements, and labor required to build and put in complete working order the buildings and appurtenances as shown on the plans and specified.
- C. All OSHA requirements pertinent to these buildings shall be followed.

3.02 MASONRY

A. Delivery, Storage, and Handling

- 1. All materials shall be so delivered, stored, and handled so as to prevent the inclusion of foreign materials and the damage of materials by water or breakage.
- 2. Package materials shall be delivered and stored in original packages until ready for use. Packages or materials showing evidence of water or other damage will be rejected. All materials shall be of the respective qualities specified herein.
- 3. Masonry units shall be handled in a manner to prevent undue chipping and breakage. Locate storage piles to avoid or be protected from heavy traffic. Pile units neatly on pallets to protect them from soil. Exercise special care to avoid soiling or staining of facing units. Any unit that becomes cracked during handling or placing will be rejected.

B. Laying, Setting, Workmanship

1. Mortars For All Masonry Work

- a. Mixing: Lime cement mortars shall be measured by volume, sand and cement mixed dry, lime putty added and then water added to bring to proper consistency for use.

Mixing of packaged cement mortars shall be in strict accord with manufacturer's directions. All mixing boxes, boards, and equipment shall be kept clean.

Mortar shall not be retempered and no mortars that have stood for more than one (1) hour shall be used.

- b. Proportions and Mixes: Lime cement mortars shall be 1 part Portland Cement, one-half lime putty and not more than 3 parts sand. Masonry cement mortars shall be 1 part masonry cement, ½ part Portland Cement and 3 parts sand.

All shall conform to A.S.T.M. C-270, Type S.

2. Workmanship

All work shall be laid plumb, level, and true and shall conform to the dimensions shown on the Drawings. All work shall be laid to a line. The work shall be properly conducted, keeping the tools, mortar boards, and other equipment in good order and free from unnecessary accumulation of mortar.

The work shall be maintained level all around building as far as practicable, but where necessary to run up part of the work in advance of the remainder, the courses shall be racked back; toothing will not be permitted.

Build-in anchorage portions of door frames and all items as required. Set all items plumb and true and in accord with the manufacturer's directions, shop drawings or details shown on drawings.

Wooden door frames shall have anchorage portions built into masonry and the space between door frames and masonry shall be trimmed-in.. Maintain 1/4" space between frames and masonry and rake out to 1/2" depth to allow for sealant.

Cutting of masonry units where necessary for electric outlet boxes, vent pipes, shall be done with a carborundum saw in a neat, workmanlike manner.

All vertical dimensions of masonry walls shall be accurately laid off on wood storey pole and the coursing and width of horizontal joints shall be carefully adjusted to produce joints of uniform width and exact vertical dimensions as shown on the Drawings. Obtain approval of the Engineer before commencing to lay up any masonry walls.

Masonry bond shall be laid out dry on the foundation wall and adjusted before starting work. All vertical joints shall be in alignment and plumb. Horizontal joints shall be level and shall line up throughout the building.

3. Sample Wall

Before laying any wall construction, the Contractor shall guild a sample wall 4' wide by 2' high. Obtain approval of sample wall form Engineer prior to working on any building wall.

4. Exterior Finish

a. Exterior Finish and Insulation System:

- 1) STO INDUSTRIES, INC.
- 2) DRIVIT

b. Environmental Requirements

- 1) Do not install finish when ambient temperature is below 40 degrees F.

- 2) Maintain this temperature during and 24 hours after installation of finish.

c. Materials

- 1) Manufacturers: Materials are specified by brand names to establish a standard quality, or by performance requirements and general description of product. The architect will consider substitutions for brand names of products specified, provided the procedures set forth for substitutions are followed. The architect reserves the right to reject any material which, in his opinion, will not produce the quality of work specified herein.

d. Surface Preparation

- 1) STO PLEX W-A water-based surface sealer and adhesion intermediary, as manufactured by STO Industries, Inc.

e. Primary Fastener (Adhesive)

- 1) STO DISPERSION ADHESIVE - A noncementitious, ready-mixed, 100% acrylic copolymer emulsion based adhesive that is waterproof and vapor permeable, as manufactured by STO Industries, Inc.

f. Insulation Board

- 1) Expanded Polystyrene (EPS Board) less than 25 flame spread, 1.0 lb./per cu. ft. average density; u=0.26 per inch; ASTM C578-85 Class A.
- 2) Dimensional tolerances shall be as follows:
 - a) Edges shall be square within 1/16" over the entire length of the board.
 - b) Thickness shall be plus or minus 1/16".
- 3) Thickness shall be 1-1/2 inches.
- 4) EPS Board shall be aged by air drying for a minimum of six weeks or equivalent kiln dried.
- 5) Maximum size of EPS Boards shall not exceed 2' x 4'.
- 6) EPS Board shall exhibit proper bead fusion and structural strength, according to STO board specifications.
- 7) Board must be manufactured and packaged by a STO approved and licensed EPS molder. Each board must be marked on its end

with a STO identification mark and packaged with proper identification information.

g. Secondary Fastener (Dowel)

- 1) STO Universal Dowel--A plastic plate fastener with a thermal cap to prevent uneven thermal and vapor diffusion. Manufactured by STO Industries, Inc.

h. Ground Coat - STO RFP

- 1) STO RFP: A ready-mixed, noncementitious, 100% acrylic copolymer emulsion-based ground coat that is water resistant, vapor permeable, glass fiber reinforced and has noncapillary action. The STO RFP shall be tinted to the same shade as the finish.
- 2) STO BTS--B: A polymer-based ground coat and leveler when mixed with 7-9 quarts of clean water per each 60 lb. bag of STO BTS--B, STO PRIMER must be applied as an adhesion intermediary, providing water resistance, and uniform absorption and color, as well as to eliminate the danger of efflorescence due to the cement content of STO BTS--B.

i. Fabric

- 1) Fabric shall be STO REINFORCING FIBER MESH with symmetrical, interlaced glass fiber made from twisted multi-end strands and coating to be alkaline resistant, at least 20 grams per square yard, for compatibility with STO Materials. The mesh shall be shift-proof, with trimmed roll edges to minimize building on overlapped seams.

j. Finish

- 1) The finish shall be exterior, ready-mixed, acrylic-based wall coatings, as manufactured by STO Industries, Inc. Texture; STOLIT 1, color selected from Manufacturer's standard colors.

k. Examination

- 1) Verify that substrate and adjacent materials are dry.
- 2) Verify substrate surface is flat, free of fins and irregularities.

l. Installation - Insulation

- 1) Install insulation in accordance with manufacturer's instructions.
- 2) Place boards in a method to maximize tight joints. Stagger

vertical joints. Butt edges and ends tight to adjacent board and to protrusions.

- 3) Secure boards to substrate and mechanical attachment to achieve a continuous flush insulation surface.

m. Installation - Coating

- 1) Install primer/adhesive, coating and reinforcement in accordance with manufacturer's instructions.

n. Performance Requirements

- 1) The Exterior Finish and Insulation System shall withstand 100 MPH wind loads.

o. Submittals

- 1) Submit under provisions of Section 0550.
- 2) Shop Drawings: Indicate soffit joint pattern and joint details.
- 3) Product Data: Provide data on system materials, product characteristics, performance criteria, and limitations.
- 4) Samples: Submit two (20, 12x12 inch size samples illustrating coating color and texture range for selection.
- 5) Manufacturer's installation instructions: Indicate preparation required, installation techniques, and jointing requirements.

p. Qualifications

- 1) Applicator: Company specializing in performing the work of this Section with minimum 5 years documented experience and approved by manufacturer.

3.03 DOORS

A. Exterior Doors

Therma-Tru doors and metal frames shall be installed in accordance with the plans and the manufacturer's recommendations. All appropriate stainless steel hardware shall be installed in accordance with the manufacturer's recommendations. The doors and frames shall be painted as shown on the plans or to the Owner's requirements.

3.04 WOOD FRAME AND ROOF

A. Site Applied Wood Treatment

Apply preservative treatment in accordance with manufacturer's instructions. Treat site-

sawn ends. Allow preservative to cure prior to erecting members.

B. Framing

Erect wood framing members level and plumb. Place horizontal members laid flat, crown-side up. Construct framing members full length without splices.

C. Sheathing

Secure roof sheathing perpendicular to framing members with ends staggered. Secure sheet edges over firm bearing. Provide solid edge blocking between sheets.

D. Tolerances

Framing Members: 1/4 inch maximum from true position.

E. Flashing Fabrication

1. From flashings (Drip Edge) protect roof assembly and shed water. Form sections square, true, and accurate to profile, in maximum possible lengths, free from distortion and other defects detrimental to appearance or performance.
2. Hem exposed edges of flashings minimum 1/4 inch on underside.
3. Apply bituminous paint on concealed surfaces of flashings.

F. Roof Installation - General

1. Install metal roofing over dry surfaces, free of ridges, warps, and voids.
2. Coordinate installation of roof mounted components or work projecting through roof. Verify roof openings are framed, sized, and located prior to installing work, of this Section.
3. Completed installation to provide weathertight services.

G. Eave Protection Installation

1. Place eave edge flashing tight with facing boards. Weather lap joints 2 inches and seal with plastic cement.
2. Apply lap cement at rate of approximately 1- 1/4 gal/square on underlayment starter strip.
3. Starting from eave edge of starter strip, lay additional 36 inch wide strips of underlayment in lap cement, to produce a two ply membrane. Weatherlap minimum 19 inches and nail in place. Lap ends minimum 6 inches. Stagger end joints of each consecutive ply.

H. Protective Underlayment Installation

1. Place one ply of underlayment over area not protected by eave membrane, with ends and edges weatherlapped minimum 6 inches. Stagger end laps of each consecutive layer. Nail protective underlayment to hold in place.
2. Install protective underlayment perpendicular to slope of roof.
3. Weather lap underlayment minimum 4 inches over eave membrane.
4. Weather lap and seal items projecting through or mounted on roof with plastic cement.

I. Flashing Installation

1. Weather lap joints minimum 2 inches and seal weathertight with plastic cement. Secure in place with nails at 16 inches on center. Conceal fastenings.
2. Flash and seal work projecting through or mounted on roofing with plastic cement.

J. Metal Roofing Installation

1. Place metal roofing in straight pattern.
2. Install metal roofing in place in accordance with manufacturer's instructions.

3.06 PAINTING

A. Scope

1. The work includes painting and finishing all interior and exterior exposed items and surfaces throughout the building. This includes field painting of exposed bare pipes and conduits (including color coding) and of hangers, exposed steel and iron work and primed metal surfaces of equipment installed under the mechanical and electrical work.
2. The object of these specifications is to provide the material and workmanship necessary to produce complete protection to the surfaces to be painted in addition to a neat appearance. Painting will be done at such times as the Contractor and Engineer may agree upon in order that dust-free and neat work can be obtained. All painting shall be done strictly in accordance with manufacturer's instructions and shall be performed in a manner satisfactory to the Engineer. All exposed piping to be painted in accordance with AWWA Standard C204 (latest edition).

B. Transportation of Materials

All materials shall be brought to the job site in the original sealed and labeled containers of the paint manufacturer and shall be subject to inspection by the Engineer.

C. Preparation of Surfaces

1. All surfaces to be painted shall be prepared in a workmanlike manner with the

objective of obtaining a clean and dry surface. No painting shall be applied before the prepared surfaces are approved by the Engineer.

2. Metal: All ferrous metal to be primed in the shop shall have all rust, dust and scale, as well as all other foreign substances, removed by sandblasting in accordance with SSPC (Steel Structures Painting Council), surface preparation specification No. 10. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent new rusting. All ferrous metals not primed in the shop shall be sandblasted in the field to SSPC No. 10 prior to application of the primer pretreatment or paint. All nonferrous metals and galvanized surfaces whether to be shop or field primed, shall be solvent cleaned prior to the application of No. 1799 V.C. - 17 Wash prime and/or primer.
3. All concrete surfaces shall be cleaned of all dust, form oil, curing compounds and other foreign matter. Before applying paint to a concrete surface, the surface must be etched. A 15-20% muriatic acid solution is effective on most concrete surfaces. Stronger solutions of muriatic acid may be required to produce the necessary slightly granular surface required to produce the adherence of the paint to the concrete. Surfaces poured with concrete containing an admixture or hardener or which are finished with a steel trowel, may require "double etching" with a 15-20% solution or with a solution of up to full strength acid before painting. Masonry wall surfaces with large pores, such as coarse cinder block and cellular concrete materials, where designated by the Engineer, shall receive one coat of 895 Unifill, prior to the application of the paint system specified.
4. Wood: Wood surfaces shall be thoroughly cleaned and free of all foreign matter, with cracks and nail holes and other defects properly filled and smoothed. Wood trim shall be sandpapered to a fine finish and wiped clean of dust.

D. Application

1. Apply no exterior paint in damp weather, or when temperature is below 50 degrees F.
2. Furnish and lay drop cloths where necessary to protect floors and adjacent work from damage.
3. On metal surfaces, the painter shall apply each coat of paint at the rate specified by the manufacturer to achieve the minimum dry mil thickness required. If material has thickened, or must be diluted for application by spray gun the coating shall be built up to the same film thickness achieved with undiluted material. In other words, one gallon of paint as originally furnished by the manufacturer must not cover a greater square foot area when applied by spray gun than when applied unthinned by brush. Deficiencies in film thickness shall be corrected by the application of an additional coat(s) of paint. On masonry, application rates will vary according to surface texture; however, in no case shall the manufacturer's stated coverage rate be exceeded. On porous surfaces, it shall be the painter's responsibility to achieve a protective and decorative finish either by decreasing the coverage rate or by applying additional coats of paint.

4. The Contractor shall submit to the Engineer, immediately upon completion of the job, certification from the manufacturer indicating that the quantity of each coating purchased was sufficient to properly coat all surfaces. Such certification shall make references to square footage figures provided to the manufacturer by the Contractor.
5. Drying time shall be construed to mean "under normal conditions". Where conditions are other than normal because of the weather or because painting must be done in confined spaces, longer drying times will be necessary. Additional coats of paint shall not be applied, nor shall units be returned to service until paints are thoroughly dry.
6. Remove any paint spots form floors, woodwork, hardware or equipment.
7. At completion, touch-up and restore finish where damaged or defaced and leave in first-class condition.

E. Paint Type and Color Schedule

1. Schedule - Exterior Surfaces
 - a. Wood - Painted
 - 1) One coat zinc chromate primer.
 - 2) Two coats alkyd enamel, gloss.
 - b. Steel - Unprimed
 - 1) One coat zinc chromate primer.
 - 2) Two coats alkyd enamel, gloss.
 - c. Steel - Shop Primed
 - 1) Touch-up with zinc chromate primer.
 - 2) Two coats alkyd enamel, gloss.
 - d. Steel - Galvanized
 - 1) One coat zinc chromate primer.
 - 2) Two coats alkyd enamel, gloss.
2. Schedule - Interior Surfaces
 - a. Wood - Painted
 - 1) One coat alkyd prime sealer.

- 2) Two coats alkyd enamel, gloss.
- b. Concrete, Concrete Block, & Pump Room
 - 1) One coat Hydro-Gard II by Crete Gard.
 - 2) Two coats Alkyd Enamel Gloss.
 - 3) In accordance with the manufacturer's Instructions to the walls and ceiling.
- c. Concrete Wetwell and Access
 - 1) Apply minimum 120 miles of Raven 405 or Spectra Shield in accordance with the manufacturer's Instructions to the walls and ceilings.
- d. Steel - Unprimed
 - 1) One coat zinc Chromate primer.
 - 2) Two coats alkyd enamel gloss.
- e. Steel - Primed
 - 1) Touch-up with original primer.
 - 2) Two coats alkyd enamel gloss.
- f. Steel - Galvanized
 - 1) One coat zinc chromate primer.
 - 2) Two coats alkyd enamel gloss.
- 3. Schedule Colors
 - a. Concrete Wetwell – Grey
 - b. Concrete Block Pump Room - White
 - c. All Piping and Fittings in Pump Room - White
 - d. Pump Frames - White
 - e. Pumps - White
 - f. Motors - Do Not Paint
 - g. Belt Guards - Orange

- h. Doors and Frame - Dark Brown
 - i. Outside Trim - White
 - j. Exterior Building - White
 - k. Interior Wood - White
4. Items to be painted but not specifically mentioned shall be painted in a color selected by the Engineer.
 5. All requirements of the Occupational Safety and Health Act (OSHA) concerning color coding and safety markings shall be considered part of these specifications.

END OF SECTION

SECTION 02791

ROOFING UNDERLAYMENT, HIGH-TEMPERATURE

PART 1 GENERAL

1.1 SUMMARY

- A. This Section specifies a self-adhering sheet membrane used as underlayment for sloped roofs.
 - 1. High temperature application, 240F resistance.
- B. Related Sections: Refer to the following specification sections for coordination:
 - 1. Section 02790 – Building Construction.
- C. Referenced Standards: Comply with the requirements of the following standards published by ASTM International to the extent referenced in this section.
 - 1. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
 - 2. ASTM D461 - Standard Test Methods for Felt.
 - 3. ASTM D 903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
 - 4. ASTM D1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
 - 5. ASTM D3767 - Standard Practice for Rubber—Measurement of Dimensions.
 - 6. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
 - 7. ASTM G90 – EMMAqua test.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with requirements of authorities having jurisdiction and applicable codes at the location of the project.
- B. Manufacturer: Minimum 10 years experience producing roofing underlayment.
- C. Installer: Minimum 2 years experience with installation of similar underlayment.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials and products in unopened factory labeled packages. Protect from damage.
- B. Cover materials and store in dry condition between temperatures of 40 and 90 degrees F (5 and 32 degrees C). Use within one year of date of manufacture. Do not store at elevated temperatures as that will reduce the shelf life of the product.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Self-Adhering Sheet Membrane Roof Underlayment:

1. Material: Cold applied, self adhering membrane composed of an innovative and proprietary rubberized asphalt adhesive and interwound with a disposable release sheet. An embossed, slip resistant surface is provided on the high performance film with UV barrier properties.
2. Membrane Thickness: 40 mils (1.02 mm) per ASTM D3767 Method A.
3. Membrane Tensile Strength: MD 33 lbf/in, CD 31 lbf/inch per ASTM D412 Die C Modified.
4. Membrane Elongation: 250% per ASTM D412 Die C Modified.
5. Low Temperature Flexibility: Unaffected at -20 degrees F (-29 degrees C) per ASTM D1970.
6. Adhesion to Plywood: 5.0 lb/in. width (876 N/m) per ASTM D903.
7. Maximum Permeance: 0.05 perms (2.9 ng/sgms Pa) per ASTM E96.
8. Maximum Material Weight Installed: 0.22 pounds/sqft (1.1 kg/sqm) per ASTM D461.
9. Service Temperature: 240 degrees F (115.6 degrees C) per ASTM D1204
10. Compatibility: Suitable for use under all types of sloped roofing with the exception high altitude climates where zinc, copper or Cor-Ten roof coverings are used.
11. Adhesive: Rubberized asphalt adhesive containing post-consumer recycled content, contains no calcium carbonate, sand or fly ash.
12. Exposure: Can be left exposed for a maximum of 120 days from date of installation per ASTM G90 – EMMAqua test.
13. Primer: Water-based Perm-A-Barrier WB Primer by Grace Construction Products.
14. Code and Standards Compliance:
 - a. ASTM D1970.
 - b. ICC-ES AC 48 Acceptance Criteria for Roof Underlayments for use in Severe Climate Areas.
 - c. Underwriters Laboratories Inc. R13399 - Class A fire classification under fiber-glass shingles and Class C under organic felt shingles (per ASTM E108/UL 790).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to start of installation, inspect existing conditions to ensure surfaces are suitable for installation of roofing underlayment. Verify flashing has been installed. Starting work indicates installers acceptance of existing conditions.

3.2 INSTALLATION

- A. Installation: Install roofing underlayment on sloped surfaces at locations indicated on the Drawings, but not less than at hips, ridges, eaves, valleys, sidewalls and chimneys, and surfaces over interior space within 36 inches (914 mm) from the inside face of the exterior wall. Strictly comply with manufacturer's installation instructions including but not limited to the following:
 1. Schedule installation such that underlayment is covered by roofing within the published exposure limit of the underlayment.

2. Do not install underlayment on wet or frozen substrates.
3. Install when surface temperature of substrate is a minimum of 40 degrees F (5 degrees C) and rising.
4. Remove dust, dirt, loose materials and protrusions from deck surface.
5. Install membrane on clean, dry, continuous structural deck. Fill voids and damaged or unsupported areas prior to installation.
6. Prime concrete and masonry surfaces using specified primer at a rate of 500-600 square feet per gallon (12-15 sqm/L). Priming is not required for other suitable clean and dry surfaces.
7. Install membrane such that all laps shed water. Work from the low point to the high point of the roof at all times. Apply the membrane in valleys before the membrane is applied to the eaves. Following placement along the eaves, continue application of the membrane up the roof. Membrane may be installed either vertically or horizontally after the first horizontal course.
8. Side laps minimum 3-1/2 inches (89 mm) and end laps minimum 6 inches (152 mm) following lap lines marked on underlayment.
9. Patch penetrations and damage using manufacturer's recommended methods.

3.02 CLEANING AND PROTECTION

- A. Protection: Protect from damage during construction operations and installation of roofing materials. Promptly repair any damaged or deteriorated surfaces.
- B. Repair minor damage to eliminate all evidence of repair. Remove and replace work which cannot be satisfactorily repaired in the opinion of the Architect.
- C. Provide temporary protection to ensure work being without damage or deterioration at time of final acceptance. Remove protective film and reclean as necessary immediately before final acceptance.

END OF SECTION

