



Lenawee County Drain Commission

320 Springbrook Avenue, Suite 102, Adrian, MI 49221

Set No. _____

Project Manual

Volume 2 of 2

Rollin-Woodstock

**Sanitary Drain Lift Station
Improvements - Rebid**

CWSRF Project No. 5728-01

September 2021

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**LENAWEE COUNTY DRAIN COMMISSIONER
ADRIAN, MI
ROLLIN-WOODSTOCK SANITARY DRAIN
LIFT STATION IMPROVEMENTS - REBID**

SEALS AND CERTIFICATIONS

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<p>Timothy Allan Harmsen, PE License No. 45885</p> 	<p>The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual:</p> <ul style="list-style-type: none">• All Sections, except those designated to others below.
<p>David M. Oberle, PE License No. 41500</p> 	<p>The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual:</p> <ul style="list-style-type: none">• Division 26, all Sections.• Section 40 68 26, Hosted Scada Service.

Lisa A. Bowe, PE
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The seal and signature to the left applies to the following Specifications Divisions and Sections of this Project Manual:

- Division 3, all Sections.
- Division 5, all Sections.
- Section 31 23 05, Excavation and Fill
- Section 32 16 13, Concrete Sidewalks

Engineer's seal and signature does not apply to the documents that comprise Division 00, Bidding and Contracting Requirements.

It is a violation of applicable laws and regulations governing professional licensing and registration for any person, unless acting under the direction of the licensed and registered design professional(s) indicated above, to alter in any way the Specifications in this Project Manual.

++ END OF SEALS AND CERTIFICATIONS ++

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SECTION 02 41 00

DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required for demolition, removal, and disposal Work.
2. The Work under this Section includes, but is not necessarily limited to:
 - a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of structural concrete, foundations, attachments, appurtenances, piping, electrical and mechanical systems and equipment, paving, sidewalks, and similar existing facilities.
 - b. Demolition and removal of all Underground Facilities underneath, and above-grade piping and utilities in, the building(s) and structures shown or indicated for demolition, unless the Underground Facilities or above-grade facilities are shown or indicated as to remain.
 - c. Remove from slabs, foundations, walls, and footings that are to be demolished all utilities and appurtenances embedded in such construction.
3. Demolitions and removals specified under other Sections shall comply with requirements of this Section.
4. Perform demolition Work within areas shown or indicated.
5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition.

B. Coordination:

1. Comply with Section 01 41 16, Coordination with Owner's Operations.
2. Review procedures under this and other Sections and coordinate the Work that will be performed with or before demolition and removals.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Demolition, removal, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T - Demolition), and all other Laws and Regulations.
2. Comply with requirements of authorities having jurisdiction.

1.3 SUBMITTALS

- A. Informational Submittals: Submit the following:
 - 1. Procedure Submittals:
 - a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
 - 1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
 - 2) Other proposed procedures as applicable.
 - 3) Equipment proposed for use in demolition operations.
 - 4) Planned demolition operating sequences.
 - 5) Detailed schedule of demolition Work in accordance with the accepted Process Schedule.
 - 2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Notification:
 - 1. At least 48 hours prior to commencing demolition or removal, notify ENGINEER in writing of planned start of demolition Work. Do not start removals without permission of ENGINEER.
- B. Protection of Surrounding Areas and Facilities:
 - 1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and free and safe access to and from, structures and properties.
 - 2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.
 - 3. Provide temporary barriers, lighting, sidewalk sheds, and other necessary protection.
 - 4. Repair damage to facilities that are to remain.

- C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, do the following:
1. Should uncharted or incorrectly charted Underground Facilities be encountered, CONTRACTOR responsibilities shall be in accordance with the General Conditions as may be modified by the Supplementary Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.
 2. Sanitary Sewer: Before proceeding with demolition, locate and cap all sewer lines and service laterals discharging from the building or structure being demolished.
 3. Storm Water: Existing storm water system shall remain in place until demolitions of existing building or structure is completed. Upon completing demolition, cut and cap storm sewer laterals at locations shown on the Drawings. Remove existing storm water piping and related structures between points of cutting, and backfill, restore to grade, and stabilize the area over the removed facilities.
 4. Water Piping: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished.
 5. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
 6. Shutdown of utility services shall be coordinated by CONTRACTOR, assisted by OWNER as required relative to contacting utility owners.

3.2 DEMOLITION – GENERAL

- A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.
- B. Pollution Controls:
1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Section 01 57 05, Temporary Controls, and Laws and Regulations.
 2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.
 3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work, in accordance with the General Conditions and Section 01 74 05, Cleaning.
- C. Comply with Section 01 73 29, Cutting and Patching.

D. Building or Structure Demolition:

1. Unless otherwise approved by ENGINEER, proceed with demolition from top of building or structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.
2. Demolish concrete and masonry in small sections.
3. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
4. Break up and remove foundations and slabs-on-grade unless otherwise shown or indicated as remaining in place.

E. Demolition of Site Improvements:

1. Pavement, Sidewalks, Curbs, and Gutters: Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
2. Fencing, Guardrails, and Bollards: Remove to the limits shown or indicated on the Drawings. Completely remove below-grade posts and concrete.
3. Manholes, Vaults, Chambers, and Handholes: Remove to the limits shown or indicated on the Drawings.
4. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes: Remove to the extent shown or indicated on the Drawings. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Section.
5. Landscaping: Comply with Section 33 11 00, Clearing and Grubbing.

F. Salvage and Ownership:

1. Unless directed otherwise by the OWNER, existing equipment and materials removed and not shown or specified to be reused in the Work will become CONTRACTOR's property.
2. Existing equipment and materials removed by CONTRACTOR shall not be reused in the Work, except where so specified or indicated.
3. Materials and equipment to remain OWNER's property shall be carefully removed and appropriately handled by CONTRACTOR to avoid damage and invalidation of warranties in effect, and shall be cleaned and stored at the Site at place designated by ENGINEER or OWNER.
 - a. Replace in kind or with new items equipment, materials, and components damaged in removal, storage, or handling through carelessness or improper procedures.
4. CONTRACTOR may furnish and install new items, with ENGINEER approval, instead of those specified or indicated to be salvaged and reused, in which case such removed items will become CONTRACTOR's property.

G. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and refinished with materials that match existing adjacent surface, or as otherwise approved by ENGINEER.

3.3 STRUCTURAL REMOVALS

- A. Remove structures to lines and grades shown or indicated, unless otherwise directed by ENGINEER. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at CONTRACTOR's expense and such excess removals shall be reconstructed to satisfaction of ENGINEER without additional cost to OWNER.
- B. Recycling and Reuse of Demolition Materials:
 - 1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by ENGINEER.
 - 2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.
- C. After removing concrete and masonry walls or portions thereof, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.
- D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.
 - 1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
 - 2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
 - 3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 inches below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
 - 4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.
- E. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, remove the anchors to not less than 1.5 inches beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by ENGINEER.
- F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.

- G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Section, unless specified elsewhere in the Contract Documents.

3.4 MECHANICAL REMOVALS

- A. Mechanical demolition and removal Work includes dismantling and removing existing piping, ductwork, pumps, equipment, tanks, and appurtenances as shown, indicated, and required for completion of the Work. Mechanical removals include cutting and capping as required, except that cutting of existing piping and ductwork to make connections is included under Section 01 14 16, Coordination with Owner's Operations; Section 01 73 29, Cutting and Patching; and applicable Sections of Division 40, Process Integration.
- B. Demolition and Removals of Piping, Ductwork, and Similar Items:
1. Purge piping and tanks (as applicable) of chemicals or fuel (as applicable) and make safe for removal and capping. Remove to the extent shown or indicated existing process, water, waste and vent, chemical, gas, fuel, and other piping. Remove piping to the nearest solid piping support, and provide caps on ends of remaining piping. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.
 2. Caps, Closures, Blind Flanges, and Plugs:
 - a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.
 - b. Where used in this Section, the term "cap" means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.
 - c. Caps shall be compatible with the piping or ductwork to which the cap is attached, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.
 - d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Section only when so shown or indicated in the Contractor Documents or when allowed by ENGINEER.
 3. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.
 4. Remove waste and vent piping, and ductwork to extent shown and cap as required. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.
 5. Modifications to potable water piping and other plumbing and heating system work shall comply with Laws and Regulations. All portions of potable water system that have been modified or opened shall be hydrostatically tested and disinfected in accordance with the Contract Documents, and Laws and Regulations. Hydrostatically test other, normally-pressurized, plumbing piping and heating piping.

C. Equipment Demolition and Removals:

1. To the extent shown or indicated, remove existing process equipment; pumps; storage tanks; hoisting and conveying equipment; heating, ventilating, and air conditioning equipment; generators; and other equipment.
2. Where required, disassemble equipment to avoid imposing excessive loading on supporting walls, floors, framing, facilities, and Underground Facilities. Disassemble equipment as required for access through and egress from building or structure. Disassembly shall comply with Laws and Regulations. Provide required means to remove equipment from building or structure.
3. Remove control panels, operator stations, and instruments associated with equipment being removed, unless shown or indicated otherwise.
4. Remove fuel appurtenances as applicable, including fuel storage tanks. Dispose of tank contents in accordance with Laws and Regulations.
5. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the "Structural Removals" Article in this Section. Remove small-diameter piping back to header unless otherwise indicated.
6. Remove access platforms, ladders, and stairs related to equipment being removed, unless otherwise shown or indicated.

3.5 ELECTRICAL REMOVALS

- A. Electrical demolition Work includes removing existing transformers, distribution switchboards, control panels, motors, starters, conduit and raceways, cabling, poles and overhead cabling, panelboards, lighting fixtures, switches, and miscellaneous electrical equipment, as shown, specified, or required.
- B. Remove existing electrical equipment and fixtures to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
- C. Remove or modify motor control centers and switchgear as shown or indicated. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.
- D. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated. Motors, microprocessors and electronics, other electrical gear to be reused shall be stored in accordance with Section 01 66 00, Product Storage and Handling Requirements.
- E. Cables in conduits to be removed shall be removed back to the power source or control panel, unless otherwise shown or indicated. Verify the function of each cable before disconnecting and removing.

- F. Conduits, raceways, and cabling shall be removed where shown or indicated. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to ENGINEER. Exposed conduits, junction boxes, other electrical appurtenances, and their supports shall be disassembled and removed. Repair all areas of the Work to prevent rusting on exposed surfaces.
- G. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
- H. Where shown or indicated, remove direct burial cable. Openings in buildings for entrance of direct burial cable shall be patched with repair mortar or other material approved by ENGINEER for this purpose, and made watertight.
- I. Existing poles and overhead cables shall be removed or abandoned as shown and specified. Existing substation(s) and poles owned by electric utility will be removed by the electric utility. Completely remove from the Site poles not owned by electric utility and shown or indicated for removal. Make necessary arrangements with electric utility for removal of utility company's transformers and metering equipment after new electrical system has been installed and energized.
- J. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as OWNER's property, shall be removed and properly disposed off-Site as required.

3.6 DISPOSAL OF DEMOLITION DEBRIS

- A. Remove from the Site all debris, waste, rubbish, and material resulting from demolition operations and equipment used in demolition Work. Comply with the General Conditions, Supplementary Conditions, and Section 01 74 05, Cleaning.
- B. Transportation and Disposal:
 - 1. Non-hazardous Material: Properly transport and dispose of non-hazardous demolition debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Asbestos, PCBs, Petroleum, Hazardous Waste, Radioactive Material, or other material designated as hazardous in Laws and Regulations.
 - 2. Hazardous Material: When handling and disposal of hazardous materials is included in the Work, properly transport and dispose of hazardous materials in accordance with the Contract Documents and Laws and Regulations.
- C. Submit to ENGINEER information required in this Section on proposed facility(ies) where demolition material will be recycled. Upon request, ENGINEER or OWNER, shall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist ENGINEER and OWNER.

3.7 SCHEDULES

- A. The supplements listed below, following the “END of SECTION” designation, are a part of this Section:
 - 1. Schedules:
 - a. Salvage Schedule.

+ + END OF SECTION + +

SALVAGE SCHEDULE

Items to be removed and retained by OWNER; delivered to and placed in storage location designated by OWNER:

1. Station "F":
 - a. Precision digital 6000 controllers
2. Station "H":
 - a. Trolley and tracks.
3. Station "L":
 - a. Variable frequency drives.
4. Station "N":
 - a. Fairbanks Morse pump.
 - b. Trolley and tracks.
 - c. Standby generator.
 - d. Automatic transfer switch.
 - e. Manual transfer switch (for portable generator).
5. Station "P":
 - a. Flygt pump.
 - b. Trolley and tracks.
6. Station "R":
 - a. Precision digital 6000 controllers.

SECTION 03 00 05

CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete, reinforcing, and related materials.
 - 2. The Work includes:
 - a. Providing concrete consisting of portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured.
 - b. Fabricating and placing reinforcing, including ties and supports.
 - c. Design, erection, and removal of formwork.
 - d. Building into the concrete all sleeves, frames, anchorage devices, inserts, and other items required to be embedded in concrete.
 - e. Providing openings in concrete as required to accommodate Work under this and other Sections.
- B. Coordination: Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Classifications of Concrete Work.
 - 1. Class "A" concrete shall be steel-reinforced and includes all concrete unless otherwise shown or indicated.
 - 2. Class "B" concrete shall be placed without forms or with simple forms, with little or no reinforcing and includes the following:
 - a. Concrete fill.
 - b. Duct banks.
 - c. Unreinforced encasements.
 - d. Curbs and gutters.
 - e. Sidewalks.
 - f. Thrust blocks.
- C. Related Sections:
 - 1. Section 05 05 33, Anchor Systems.
 - 2. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ACI 224R, Control of Cracking in Concrete Structures.
 - 2. ACI 301, Specifications for Structural Concrete for Buildings.
 - 3. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - 4. ACI 305R, Specification for Hot Weather Concreting.

5. ACI 306R, Cold Weather Concreting.
6. ACI 309R, Guide for Consolidation of Concrete.
7. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
8. ACI 347, Guide to Formwork for Concrete.
9. ACI SP-66, ACI Detailing Manual.
10. ASTM A82/A82M, Specification for Steel Wire, Plain, for Concrete Reinforcement.
11. ASTM A185/A185M, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
12. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
13. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
14. ASTM C33/C33M, Specification for Concrete Aggregates.
15. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
16. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
17. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
18. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
19. ASTM C143/C143M, Test Method for Slump of Hydraulic-Cement Concrete.
20. ASTM C150/C150M, Specification for Portland Cement.
21. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
22. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
23. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
24. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
26. ASTM C579, Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
27. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
28. ASTM D1752, Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
29. CRSI MSP1, Manual of Standard Practice.

1.3 ADDITIONAL WORK ITEMS

- A. Item A.1 –Additional Class “A” Concrete: Provide under the provisions of Section 01 22 13, Measurement and Payment.
- B. Item A.2 –Additional Reinforcing Steel: Provide under the provisions of Section 01 22 13, Measurement and Payment.

1.4 QUALITY ASSURANCE

- A. Laboratory Trial Batch:
 - 1. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
 - 2. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
 - 3. Perform the following testing on each trial batch:
 - a. Aggregate gradation for fine and coarse aggregates.
 - b. Slump.
 - c. Air content.
 - d. Compressive strength based on cylinders tested at seven days and at 28 days.
 - 4. Submit for each trial batch the following information:
 - a. Project identification name and number (if applicable).
 - b. Date of test report.
 - c. Complete identification of aggregate source of supply.
 - d. Tests of aggregates for compliance with the Contract Documents.
 - e. Scale weight of each aggregate.
 - f. Absorbed water in each aggregate.
 - g. Brand, type, and composition of cementitious materials.
 - h. Brand, type, and amount of each admixture.
 - i. Amounts of water used in trial mixes.
 - j. Proportions of each material per cubic yard.
 - k. Gross weight and yield per cubic yard of trial mixtures.
 - l. Measured slump.
 - m. Measured air content.
 - n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28-day test, and for each design mix.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. List of concrete materials and concrete mix designs proposed for use. Include results of tests performed to qualify the materials and to establish the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.
 - b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
 - c. Concrete placement drawings showing the location and type of all joints.

- d. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI SP-66. For walls and masonry construction, provide elevations to a minimum scale of 1/4-inch to one foot. Show bar schedules, stirrup spacing, adhesive dowels, splice lengths, diagrams of bent bars, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing.
 - 2. Product Data:
 - a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
 - 3. Samples:
 - a. Samples: Submit samples of materials as specified and as otherwise requested by ENGINEER, including names, sources, and descriptions.
- B. Informational Submittals: Submit the following:
- 1. Delivery Tickets: Copies of all delivery tickets for each load of concrete delivered to or mixed at the Site. Each delivery tickets shall contain the information in accordance with ASTM C94/C94M along with project identification name and number (if any), date, mix type, mix time, quantity and amount of water introduced.
 - 2. Site Quality Control Submittals:
 - a. Report of testing results for testing of field concrete cylinders for each required time period. Submit within 24 hours after completion of associated test. Test report shall include results of all testing required at time of sampling.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Transportation, Delivery, and Handling:
- 1. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.
 - 2. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
 - 3. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.
 - 4. Deliver grout materials from manufacturers in unopened containers that bear intact manufacturer labeling.
 - 5. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage:

1. Store formwork materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.
2. Store concrete reinforcing materials to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does not come into contact with the ground. Space framework or blocking supports to prevent excessive deformation of stored materials.
3. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight.
4. For storage of concrete materials, provide bins or platforms with hard, clean surfaces.
5. Comply with Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type II.

B. Aggregates: ASTM C33/C33M.

1. Fine Aggregate: Clean, sharp, natural sand free of loam, clay, lumps, and other deleterious substances. Dune sand, bank run sand, and manufactured sand are unacceptable.
2. Coarse Aggregate:
 - a. Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.
 - b. Coarse aggregate shall comply with the following:
 - 1) Crushed stone, processed from natural rock or stone.
 - 2) Washed gravel, either natural or crushed. Slag, pit gravel, and bank-run gravel are not allowed.
 - c. Coarse Aggregate Size: ASTM C33/C33M, Nos. 57 or 67, unless otherwise approved by ENGINEER.

C. Water: Clean, potable.

D. Admixtures:

1. Air-Entraining Admixture: ASTM C260.
2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
3. Water Reducing and Set-Adjusting Admixtures: ASTM C494/C494M, Types D and E.
4. High Range Water-Reducing Admixture: ASTM C494/C494M, Type F/G.
5. Use only admixtures that have been tested and approved in the mix designs.
6. Do not use calcium chloride or admixtures containing chloride ions.

2.2 CONCRETE MIX

- A. General:
 - 1. Normal weight: 145 pounds per cubic foot.
 - 2. Use air-entraining admixture in all concrete. Provide not less than four percent, nor more than eight percent, entrained air for concrete exposed to freezing and thawing, and provide from three to five percent entrained air for other concrete.
- B. Proportioning and Design of Class "A" Concrete Mix:
 - 1. Minimum compressive strength at 28 days: 4,500 psi.
 - 2. Maximum water-cement ratio by weight: 0.45.
 - 3. Minimum cement content: 564 pounds per cubic yard.
- C. Proportioning and Design of Class "B" Concrete Mix:
 - 1. Minimum compressive strength at 28 days: 3,000 psi.
 - 2. Maximum water-cement ratio by weight: 0.50.
 - 3. Minimum cement content: 517 pounds per cubic yard.
- D. Slump Limits:
 - 1. Proportion and design mixes to result in concrete slump at point of placement of not less than one inch and not more than four inches.
 - 2. When using high-range water reducers, slump prior to addition of admixture shall not exceed three inches. Slump after adding admixture shall not exceed eight inches at point of placement.
- E. Adjustment of Concrete Mixes:
 - 1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
 - 2. Submit for ENGINEER's approval laboratory test data for adjusted concrete mix designs, including compressive strength test results.
 - 3. Implement adjusted mix designs only after ENGINEER's approval.
 - 4. Adjustments to concrete mix designs shall not result in additional costs to OWNER.

2.3 FORM MATERIALS

- A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection. CONTRACTOR shall be responsible for designing the formwork system to resist all applied loads including pressures from fluid concrete and construction loads.
- B. Smooth Form Surfaces: Acceptable panel-type to provide continuous, straight, smooth, as-cast surfaces in accordance with ACI 301.
- C. Unexposed Concrete Surfaces: Material to suit project conditions.

- D. Provide 3/4-inch chamfer at all external corners. Chamfer is not required at re-entrant corners unless otherwise shown or indicated.
- E. Form Ties:
 - 1. Provide factory-fabricated, removable, or snap-off metal form ties, that prevent form deflection and prevent spalling of concrete surfaces upon removal. Materials used for tying forms are subject to approval of ENGINEER.
 - 2. Unless otherwise shown or indicated, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5 inches from outer surface of concrete. Unless otherwise shown or indicated, provide form ties that, upon removal, will leave a uniform, circular hole not larger than one-inch diameter in the concrete surface.
 - 3. Ties for exterior walls, below-grade walls, and walls subject to hydrostatic pressure shall be provided with waterstops.
 - 4. Wire ties are unacceptable.

2.4 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed bars.
- B. Welded Wire Fabric: ASTM A185/A185M.
- C. Steel Wire: ASTM A82/A82M.
- D. Provide supports for reinforcing including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing in place.
 - 1. Use wire bar-type supports complying with CRSI MSP1 recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
 - 2. For slabs on grade, use precast concrete blocks, four inches square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.
 - 3. For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP1.
 - 4. Provide precast concrete supports over waterproof membranes.
- E. Adhesive Dowels:
 - 1. Dowels:
 - a. Dowel reinforcing bars shall comply with ASTM A615, Grade 60.
 - 2. Adhesive:
 - a. For requirements for adhesive, refer to Section 05 05 33, Anchor Systems.

2.5 RELATED MATERIALS

A. Waterstops:

1. Hydrophilic Waterstops:

- a. Products and Manufacturers: Provide one of the following:
 - 1) NP190, by JP Specialties, Inc.
 - 2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
 - 3) Hydrotite, by Sika Corporation.
 - 4) Or equal.
- b. Hydrophilic waterstop materials shall be bentonite-free and shall expand by minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
- c. Waterstop material shall be composed of resins and polymers that absorb water and cause a completely reversible and repeatable increase in volume.
- d. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
- e. Select material in accordance with manufacturer's recommendations for type of liquid to be contained.
- f. Minimum cross-sectional dimensions: 3/16-inch by 3/4-inch.
- g. Location of hydrophilic waterstops shall be as shown or indicated on the Drawings, or where approved by ENGINEER.
- h. Hydrophilic Sealant: Shall adhere firmly to concrete, metal, and PVC in dry or damp condition and be indefinitely elastic when cured.
 - 1) Products and Manufacturers: Provide sealant compatible with selected manufacturer waterstop.

B. Membrane-Forming Curing Compound: ASTM C309, Type I.

C. Epoxy Bonding Agent:

1. Two-component epoxy resin bonding agent.
2. Products and Manufacturers: Provide one of the following:
 - a. Sikadur 32, Hi-Mod LPL, by Sika Corporation.
 - b. Eucopoxy LPL, by the Euclid Chemical Company.
 - c. Or equal.

D. Epoxy-Cement Bonding Agent:

1. Three-component blended epoxy resin-cement bonding agent.
2. Products and Manufacturers: Provide one of the following:
 - a. Sika Armatec 110 EpoCem, by Sika Corporation.
 - b. Duralprep A.C., by Euclid Chemical Company.
 - c. Or equal.

E. Preformed Expansion Joint Filler:

1. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

F. Joint Sealant and Accessories:

1. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07 92 00, Joint Sealants.

2.6 GROUT

A. Non-shrink Grout:

1. Pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site.
2. Minimum 28-day Compressive Strength: 7,000 psi.
3. Products and Manufacturers: Provide one of the following:
 - a. NS Grout by Euclid Chemical Company.
 - b. Set Grout by Master Builders, Inc.
 - c. NBEC Grout by Five Star Products, Inc.
 - d. Or equal.

B. Epoxy Grout:

1. Pre-packaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
2. Minimum Seven-day Compressive Strength: 14,000 psi, when tested in accordance with ASTM C579.
3. Products and Manufacturers: Provide one of the following:
 - a. Euco High Strength Grout, by Euclid Chemical Company.
 - b. Sikadur 42, Grout Pak, by Sika Corporation.
 - c. Five Star Epoxy Grout, by Five Star Products, Inc.
 - d. Or equal.

C. Grout Fill:

1. Grout mix shall consist of cement, fine and coarse aggregates, water, and admixtures complying with requirements specified in this Section for similar materials in concrete.
2. Proportion and mix grout fill as follows:
 - a. Minimum Cement Content: 564 pounds per cubic yard.
 - b. Maximum Water-Cement Ratio: 0.45.
 - c. Maximum Coarse Aggregate size: 1/2-inch, unless otherwise indicated.
 - d. Minimum 28-day Compressive Strength: 4,000 psi.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the substrate and the conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 FORMWORK

- A. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation, and position.
- B. Provide openings in formwork to accommodate the Work of other trades. Accurately place and securely support items required to be built into formwork.
- C. Clean and adjust forms prior to placing concrete. Apply form release agents or wet forms as required. Re-tighten forms during and after concrete placing, when required, to eliminate cement paste leaks.
- D. Removing Formwork:
 - 1. Comply with ACI 301 and ACI 347, except as otherwise indicated in the Contract Documents.
 - 2. Do not remove formwork and shoring until supported concrete members have acquired minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field-cured specimens may be submitted to ENGINEER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated in the Contract Documents.
 - 3. Removal time for formwork is subject to ENGINEER's acceptance.
 - 4. Repair form tie-holes following in accordance with ACI 301.

3.3 REINFORCING, JOINTS, AND EMBEDDED ITEMS

- A. Comply with the applicable recommendations of Laws and Regulations and standards referenced in this Section, including CRSI MSP1, for details and methods of placing and supporting reinforcing.
- B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials which act to reduce or destroy bond between reinforcing material and concrete.
- C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers, and hangers, as required.
 - 1. Place reinforcing to obtain minimum concrete coverages as shown on the Drawings and as required in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
 - 2. Do not secure reinforcing to formwork using wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.

- D. Provide sufficient quantity of supports of strength required to carry reinforcing. Do not place reinforcing more than two inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.
- E. Splices: Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown or indicated for minimum lap of spliced bars, as shown on the Drawings.
- F. Install welded wire fabric in lengths as long as practical, lapping adjoining sections a minimum of one full mesh.
- G. Do not place concrete until reinforcing is inspected and ENGINEER indicates that conditions are acceptable for placing concrete. Concrete placed in violation of this paragraph will be rejected. Notify ENGINEER in writing at least two working days prior to proposed concrete placement.
- H. Joints:
 - 1. Provide construction, isolation, expansion, and control joints as indicated or required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs-on-grade to stabilize differential settlement and random cracking.
 - 2. In walls, locate joints at a maximum spacing of 40 feet and approximately 12 feet from corners.
 - 3. In foundation slabs and slabs-on-grade, locate joints at intervals of approximately 40 feet or as shown on the Drawings.
 - 4. In mats and structural slabs and beams, locate joints in compliance with ACI 224R.
 - 5. Locations of joints shall be in accordance with the Contract Documents and as approved by ENGINEER in the Shop Drawings.
 - 6. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously-placed concrete to amplitude of 1/4-inch.
- I. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by, cast-in-place concrete. Use setting diagrams, templates, and instructions provided under other Sections for locating and setting. Refer to Paragraph 1.1.B of this Section. Do not embed in concrete uncoated aluminum items. Where aluminum items are in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.
- J. Adhesive Dowels:
 - 1. Adhesive dowels shall be reinforcing bar dowels set in an adhesive in hole drilled into hardened concrete. Comply with adhesive system manufacturer's installation instructions regarding hole diameter, drilling method, embedment depth required to fully develop required tensile strength, and hole cleaning and preparation instructions. Unless more-stringent standards are required by adhesive system manufacturer, comply with the following.

2. Drill holes to adhesive system manufacturer's recommended diameter and depth to develop required tensile strength. Holes shall not be more than 1/4-inch greater than nominal bar diameter, and hole depth shall not be less than twelve times nominal bar diameter. Hammer-drill holes. Cored holes are not allowed.
3. Embedment depths shall be based on concrete compressive strength of 4,000 psi.
4. Determine location of existing reinforcing steel in vicinity of proposed holes prior to drilling. Adjust location of holes to be drilled to avoid drilling through or damaging existing reinforcing bars only when approved by ENGINEER.
5. Before setting adhesive dowel, hole shall be free of dust and debris using method recommended by adhesive system manufacturer. Hole shall be brushed, with manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
6. Inject adhesive into hole through injection system mixing nozzle and necessary extension tubes, placed to bottom of hole. Withdraw discharge end as adhesive is placed, but keep end of tube immersed to prevent forming air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placement.
7. Twist dowels during insertion into partially-filled hole to guarantee full wetting of bar surface with adhesive. Insert bar slowly to avoid developing air pockets.

3.4 CONCRETE PLACING

- A. Site Mixing: Use drum-type batch machine mixer, mixing not less than 1.5 minutes for one cubic yard or smaller capacity. Increase required mixing time by minimum of 15 seconds for each additional cubic yard or fraction thereof.
- B. Ready-Mixed Concrete: Comply with ASTM C94/C94M.
- C. Concrete Placing:
 1. Place concrete in a continuous operation within planned joints or sections in accordance with ACI 304R.
 2. Do not begin placing concrete until work of other trades affecting concrete is completed.
 3. Wet concrete and subgrade surfaces to saturated surface dry condition immediately prior to placing concrete.
 4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
 5. Avoid separation of the concrete mixture during transportation and placing. Concrete shall not free-fall for distance greater than four feet during placing.
 6. Complete concrete placing within 90 minutes of addition of water to the dry ingredients.

- D. Consolidate placed concrete in accordance with ACI 309R using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around placing and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly-spaced locations. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or placing is not allowed.
- E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placing, and curing.
 - 1. In hot weather comply with ACI 305R.
 - 2. In cold weather comply with ACI 306R.

3.5 QUALITY OF CONCRETE WORK

- A. Make concrete solid, compact, smooth, and free of laitance, cracks, and cold joints.
- B. Concrete for liquid-retaining structures and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
- C. Cut out and properly replace to extent directed by ENGINEER, or repair to satisfaction of ENGINEER, surfaces that contain cracks or voids, are unduly rough, or are in defective in any way. Patches or plastering are unacceptable.
- D. Repair, removal and replacement of defective concrete directed by ENGINEER shall be at no additional cost to OWNER.

3.6 CURING

- A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by using moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection, as required, to prevent damage to exposed concrete surfaces. Total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

3.7 FINISHING

- A. Slab Finish:
 - 1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Use a wood float only. Check and level surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture. Slab surfaces shall receive a float finish. Provide additional trowel finishing as required in this Section.

2. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
3. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten-foot straightedge. Grind smooth surface defects that would telegraph through applied floor covering system.
4. Use trowel finish for the following:
 - a. Interior exposed slabs, unless otherwise shown or indicated.
 - b. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown.

B. Formed Finish:

1. Provide smooth form concrete finish at exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces include interior water-contacting surfaces of tanks, whether or not directly visible. All surfaces shall be considered as exposed, unless buried or covered with permanent structural or architectural material. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/8-inch in height. Where surface will be coated or will receive further treatment, remove all fins flush with concrete surface.
2. Provide rough form finish at all unexposed surfaces. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/2-inch in height.

3.8 GROUT PLACING

- A. Place grout as shown and indicated, and in accordance with grout manufacturer's instructions and recommendations. If grout manufacturer's instructions conflict with the Contract Documents, notify ENGINEER and not proceed until obtaining ENGINEER's clarification.
- B. Dry-packing is not allowed, unless otherwise indicated.
- C. Manufacturers of proprietary grout materials shall make available upon 72 hours notice the services of qualified, full-time, factory-trained employee to aid in ensuring proper use of grout materials at the Site.
- D. Placing grout shall comply with temperature and weather limitations described in Article 3.4 of this Section.

3.9 FIELD QUALITY CONTROL

A. Site Testing Services:

1. CONTRACTOR shall employ independent testing laboratory to perform field quality control testing for concrete under Bid Item 2. Owner Furnished Construction Materials Testing Lump Sum Cash Allowance. ENGINEER will direct where samples are obtained.
2. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
3. CONTRACTOR shall provide curing and necessary cylinder storage in accordance with Section 01 45 28, On-Site Facilities for Testing Laboratory.

B. Quality Control Testing During Construction:

1. Perform sampling and testing for field quality control during concrete placing, as follows:
 - a. Sampling Fresh Concrete: ASTM C172.
 - b. Slump: ASTM C143/C143M; one test for each concrete load at point of discharge.
 - c. Concrete Temperature: ASTM C1064/C1064M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
 - d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
 - e. Unit Weight: ASTM C138/C138M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
 - f. Compression Test Specimens:
 - 1) In accordance with ASTM C31/C31M, make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be six standard cylinders, unless otherwise directed by ENGINEER.
 - 2) Cast, store, and cure specimens in accordance with ASTM C31/C31M.
 - g. Compressive Strength Tests:
 - 1) In accordance with ASTM C39/C39M; one specimen tested at seven days, and three specimens tested at 28 days. Two additional cylinders shall be held in reserve for additional testing as directed by ENGINEER.
 - 2) Concrete that does not comply with strength requirements will be considered as defective Work.
 - h. Submit test results from certified by testing laboratory to ENGINEER within 24 hours of completion of test.

- i. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, CONTRACTOR shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42/C42M and the following:
 - 1) Testing of Adhesive Dowels: CONTRACTOR will employ testing agency to perform field quality control testing of drilled dowel installations. After adhesive system manufacturer's recommended curing period and prior to placing connecting reinforcing, proof-test for pullout ten percent of adhesive dowels installed. Adhesive dowels shall be tensioned to 60 percent of specified yield strength. Where dowels are located less than six bar diameters from edge of concrete, ENGINEER will determine tensile load required for test. If one or more dowels fail, retest all dowels installed for the Work. Dowels that fail shall be reinstalled and retested at CONTRACTOR's expense.

+ + END OF SECTION + +

SECTION 05 05 33

ANCHOR SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
 - 2. This Section includes all anchor systems required for the Work, but not specified under other Sections.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills And Blanks For Carbide-tipped Masonry Drills.
 - 2. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 3. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - 4. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
 - 5. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
 - 2. Post-installed Anchor Installer: Shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
 - 2. Product Data:
 - a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
 - b. When required by ENGINEER, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
 - b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
 - 2. Manufacturer's Instructions:
 - a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).

1.5 DELIVERY, STORAGE AND HANDLING

- A. Storage and Protection:
 - 1. Keep materials dry during delivery and storage.
 - 2. Store adhesive materials within manufacturer's recommended storage temperature range.
 - 3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. General:
 - 1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.

2. Stainless Steel Nuts:
 - a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
 - b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.

B. Design Criteria:

1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
 - a. Anchor Bolts: Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph 3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.
 - b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.
 - 1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.
 - 2) Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.

- 3) Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
 - 4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.
 - 5) Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.
 - 6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.
2. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:
- a. Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.
 - b. Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
 - c. Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.
 - d. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to a design professional retained by CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents.

C. Application:

1. Concrete Adhesive Anchors:
 - a. Use where adhesive anchors are shown or indicated for installation in concrete.
 - b. Suitable for use where subject to vibration.
 - c. Suitable for use in exterior locations or locations subject to freezing.
 - d. Suitable for use in submerged, intermittently submerged, or buried locations.

- e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
- f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.

2.2 MATERIALS

A. Concrete Adhesive Anchors:

1. General:
 - a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
 - a. HIT-RE 500 V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
 - b. SET-XP Epoxy-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
 - c. Or equal.
3. Adhesive:
 - a. Adhesive system shall use two-component adhesive mix.
 - b. Epoxy adhesives shall comply with physical requirements of ASTM C881/C881M, Type IV, Grade 2 and 3, Class A, B, and C, except gel times.
 - c. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308.
 - d. Adhesives shall have minimum bond strength and minimum design bond strength (bond strength multiplied by strength reduction factor) in accordance with Table 05 05 33-A:

**TABLE 05 05 33-A:
ADHESIVE BOND STRENGTH^{1,2}**

Anchor Rod Diameter / Dowel Size	Uncracked Concrete		Cracked Concrete	
	Bond Strength (psi)	Design Bond Strength (psi)	Bond Strength (psi)	Design Bond Strength (psi)
3/8-inch / #3	2040	1300	1090	700
1/2-inch / #4	1920	1200	920	560
5/8-inch / #5	1830	1150	710	390
3/4-inch / #6	1760	1050	710	460
7/8-inch / #7	1670	900	610	340
1-inch / #8	1650	1050	850	460
1 1/8-inch / #9	1900	1000	800	400
1 1/4-inch / #10	1580	1000	730	400

Table Notes:

1. Bond strengths listed for hammer-drilled, dry hole.
2. Bond strengths listed for maximum short term concrete temperature of 110 degrees F and maximum long term concrete temperature of 75 degrees F.

4. Anchor:
 - a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
- B. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.
- C. Anti-Seizing Compound:
 1. Products and Manufacturers: Provide one of the following:
 - a. Pure Nickel Never-Seez, by Bostik.
 - b. Nickel-Graf, by Anti-Seize Technology.
 - c. Or equal.
 2. Provide pure nickel anti-seizing compound.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A:

- A. General:
 1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.
- B. Adhesive Anchors:
 1. Comply with manufacturer's written installation instructions and the following.
 2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.

3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
9. Limitations:
 - a. At time of anchor installation, concrete shall have compressive strength (f'c) of not less than 2,500 psi.
 - b. At time of anchor installation, concrete shall have age of not less than 21 days.
 - c. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
 - d. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
 - e. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

C. Anti-Seizing Compound:

1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1 of this Section.
2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

- A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Services:
 - 1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

+ + END OF SECTION + +

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install joint sealants.
 - 2. Extent of each type of calking and sealant is shown or indicated and includes the following:
 - a. Interior and exterior joints in equipment and construction systems not filled by another material, and that are not required to be open for operation.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before joint sealants.
 - 2. Coordinate final selection of joint sealants so that materials are compatible with all calking and sealant substrates specified.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ASTM C510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
 - 2. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
 - 3. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
 - 4. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
 - 5. ASTM C920, Specification for Elastomeric Joint Sealants.
 - 6. ASTM C1021, Practice for Laboratories Engaged in Testing Building Sealants.
 - 7. ASTM C1087, Test method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
 - 8. ASTM C1193, Guide for Use of Joint Sealants.
 - 9. ASTM C1247, Practice for Durability of Sealants Exposed to Continuous Immersion in Liquids.
 - 10. BAAQMD Regulation 8, Rule 51.
 - 11. FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
 - 12. FS TT-S-00230 Sealing Compound: Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).

13. NSF/ANSI Standard 61, Drinking Water System Components - Health Effects.
14. SCAQMD Rule 1168.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 1. Installer:
 - a. Engage a single installer, approved by product manufacturer, regularly engaged in calking and sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of Work required.
 2. Testing Laboratory:
 - a. Furnish services of independent testing laboratory qualified according to ASTM C1021, for conducting testing required.
- B. Component Supply and Compatibility:
 1. Obtain materials only from manufacturers who will, if required:
 - a. Test joint sealants for compatibility with substrates for conformance with FS-TT-S-00227, and recommend remedial procedures as required.
 2. Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Shop Drawings and other approved submittals.
- C. Product Testing: Provide test results of laboratory pre-construction compatibility and adhesion testing, as specified in Article 3.1 of this Section, by qualified testing laboratory, based on testing of current sealant formulations within a 36-month period preceding the Notice to Proceed for the Work.
 1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920 and, where applicable, to other standard test methods.
 2. Test other joint sealants for compliance using specified post-construction field adhesion test.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Schedule of joint sealants installation, indication each specific surface where calking or sealants are to be provided and the material proposed for each application.

2. Product Data:
 - a. Copies of manufacturer's data sheets including color charts, specifications, recommendations, and installation instructions for each type of sealant, calking compound, and associated miscellaneous material required. Include manufacturer's published data, indicating that each product complies with the Contract Documents and is intended for the applications shown or indicated.
 - b. Product test reports.
3. Samples:
 - a. Each type of actual cured material of each calking and sealant specified, in each of manufacturer's standard colors.
 - b. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is responsibility of CONTRACTOR.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Certify that materials are suitable for intended use and materials meet or exceed requirements of the Contract Documents.
 - b. Certification from manufacturer that products furnished are appropriate for surfaces and conditions to which they will be applied.
 - c. Certify that applicator is approved by manufacturer.
2. Field Quality Control Submittals:
 - a. Results of tests on job mock-ups.
 - b. Pre-construction and post-construction field test reports.
 - c. Compatibility and adhesion test reports.
 - d. Contractor's Field Test Report Logs:
 - 1) Indicate time present at the Site.
 - 2) Include observations and results of field tests, and document compliance with manufacturer's installation instructions and supplemental instructions provided to installers.
3. Qualifications: Submit qualifications for:
 - a. Installer.
 - b. Testing laboratory (if not already submitted under Section 01 45 23, Testing Laboratory Services Furnished by Owner, or Section 01 45 13, Testing Laboratory Services Furnished by Contractor).

C. Closeout Submittals: Submit the following:

1. and Maintenance Data:
 - a. inspection intervals.
 - b. for repairing and replacing failed sealant joints.
2. Warranty: Submit written warranties as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 65 00, Product Delivery Requirements, and Section 01 66 00, Product Storage and Handling Requirements, and the following:
 - 1. Delivery of Products:
 - a. Deliver products in calking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
 - b. Include the following information on label:
 - 1) Name of material and Supplier.
 - 2) Formula or Specification Section number, lot number, color and date of manufacture.
 - 3) Mixing instructions, shelf life, and curing time, when applicable.
 - 2. Storage of Products:
 - a. Do not store or expose materials to temperature above 90 degrees F or store in direct sunlight.
 - b. Do not use materials that are outdated as indicated by shelf life.
 - c. Store sealant tape in manner that will not deform tape.
 - d. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 75 degrees F.
 - e. When high temperatures prevail, store mixed sealants in a cool place.
 - 3. Handling:
 - a. not open containers or mix components until necessary preparatory Work and priming are complete.

1.6 JOB CONDITIONS

- A. Environmental Conditions:
 - 1. Do not install joint sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
 - 2. Proceed with the Work when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
 - 3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
 - 4. When high temperatures prevail, avoid mixing sealants in direct sunlight.
 - 5. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
 - 6. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.

7. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas of calking, sealants, and painting Work, and areas where OWNER's personnel or construction personnel may work. Properly locate and vent such heat sources to outdoors so that joint sealants and other Work are unaffected by exhaust.

1.7 WARRANTY

- A. Provide written warranty, signed by manufacturer and CONTRACTOR, agreeing to repair or replace sealants that fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in approved Shop Drawings and other submittals, as an inherent quality of material for exposure indicated.
 1. Provide manufacturer warranty for period of one year from date of Substantial Completion of joint sealants Work.
 2. Provide installer warranty for period of two years from date of Substantial Completion of joint sealants Work.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. VOC Performance Criteria:
 1. VOC content of sealants used shall comply with current VOC content limits of SCAQMD Rule 1168. Sealants used as fillers shall comply with or exceed requirements of BAAQMD Regulation 8, Rule 51.
 - a. Sealants: 250 g/L.
 - b. Sealant Primers for Nonporous Substrates: 250 g/L.
 - c. Sealant Primers for Porous Substrates: 775 g/L.
- C. Provide colors selected by ENGINEER from calking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide same generic products and colors as available from manufacturers specified.

2.2 MATERIALS

A. Exterior and Interior Horizontal and Vertical Joints; Submerged and Intermittently Submerged in Wastewater:

1. Two-component Polyurethane Sealant:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Sikaflex- 2c NS by Sika Corporation.
 - 2) Vulkem 227 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
 - 3) Or equal.
 - b. Polyurethane based, two-component elastomeric sealant complying with:
 - 1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
 - 2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 18 lbs.
 - 3) Hardness (Standard Conditions), ASTM C661: 25 (Shore A).
 - 4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
 - 5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
 - 6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
 - 7) Content: 220 grams per liter, maximum.

B. Miscellaneous Materials:

1. Joint Cleaner: As recommended by calking and sealant manufacturer.
2. Joint Primer and Sealer: As recommended for compatibility with calking and sealant by calking and sealant manufacturer.
3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended for compatibility with calking and sealant by calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape where applicable.
4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by calking and sealant manufacturer. Provide size and shape of rod that will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide highly-compressible backer to minimize possibility of sealant extrusion when joint is compressed.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which calking and sealant Work will be performed, and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work and performance of sealants. Do not proceed with calking and sealant Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Protection: Do not allow joint sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or calking and sealant materials.
- B. Joint Surface Preparation:
 - 1. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
 - 2. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.
 - 3. Roughen joint surfaces on vitreous coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
 - 4. Concrete Joint Preparation: Refer to Section 03 15 00, Concrete Accessories

3.3 INSTALLATION

- A. Install joint sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure calking and sealant joints will not be soiled. Replace calking and sealant joints soiled after installation.
- B. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents, and except where manufacturer's technical representative directs otherwise, only as acceptable to ENGINEER.
- C. Prime or seal joint surfaces as shown on approved Shop Drawings and approved other submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.
- D. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

- E. Confirm that compressible filler is installed before installing sealants. Refer to Section 04 05 05, Unit Masonry Construction, for locations.
- F. Do not install sealants without backer rods and bond breaker tape.
- G. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.
- H. Employ only proven installation techniques that will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete “wetting” of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- I. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
 - 1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
 - 2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.
- J. Remove excess and spillage of compounds promptly as the Work progresses.
- K. Cure caulking and sealant compounds in compliance with manufacturer’s instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.

3.4 EXISTING JOINTS

- A. Mechanically remove existing sealant and backer rod.
- B. Clean joint surfaces of residual sealant and other contaminants capable of affecting sealant bond to joint surface.
- C. Conduct laboratory pre-construction compatibility and adhesion testing on joint surfaces in accordance with Paragraph 3.1.B of this Section.
- D. Allow joint surfaces to dry before installing new sealants.

3.5 FIELD QUALITY CONTROL

- A. Water Leak Testing: Field test for water leaks as follows:
 - 1. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, two feet from joint and connected to water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
 - 2. Test approximately five percent of total joint system, in locations that are typical of every joint condition, and that can be inspected easily for leakage on opposite face. Conduct test in presence of ENGINEER, who will determine actual percentage of joints to be tested and actual period of exposure to water from hose, based on extent of observed leakage or lack of observed leakage.
 - 3. Where nature of observed leaks indicates potential of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion.

3.6 ADJUSTING AND CLEANING

- A. Where leaks and lack of adhesion are evident, replace sealant.
- B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish Work in neat, clean condition.
- C. Protect sealants during construction so that they will be without deterioration, soiling, or damage at time of readiness for final payment of the Contract.

3.7 PROTECTION

- A. During and after curing period, protect joint sealants from contact with contaminating substances and from damage resulting from construction operations or other causes, so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original Work.

++ END OF SECTION ++

SECTION 09 91 00

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
 - a. CONTRACTOR is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included under this and other Sections.

B. Coordination:

1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.
2. Coordinate primers with finish paint materials to provide primers that are compatible with finish paint materials.

C. Description of Colors and Finishes:

1. Color Coding of Equipment:
 - a. Finish coats of paint for equipment shall be coded in basic colors. Colors shall be brilliant, distinctive shades matching the following safety and pipeline colors per ANSI Z535.1, Recommended Standards for Water Works; Recommended Standards for Wastewater Facilities, color specifications for safety colors and other primary colors:

TABLE 09 91 00-A

TABLE OF STANDARD COLORS

<u>Color</u>	<u>Designation*</u>
Brown	Terra Cotta; 07RD
Yellow	Lemon/Safety Yellow; 02SF

*Color designations are provided per Tnemec Company, Inc. paint color numbers and are provided as a standard of quality; equivalent colors matching these colors are acceptable. Provide with Shop Drawing submittal direct color comparisons of color numbers available from manufacturer submitted.

- b. General Color Code: Unless otherwise specified, use the following color code:

TABLE 09 91 00-B

COLOR TABLE

<u>Equipment</u>	<u>Color</u>
Guard Posts	Yellow
Vent	Brown

- c. Color of final coats shall match as closely as possible, without custom blending, color tabulated for specific service.

1.2 REFERENCES

- A. Referenced Standards: Standards referenced in this Section are:
1. ANSI Z535.1, Safety Color Code.
 2. ASTM D16, Terminology for Paint, Related Coatings, Materials and Applications.
 3. ASTM D4258, Practice for Surface Cleaning Concrete for Coating.
 4. ASTM D4259, Practice for Abrading Concrete.
 5. SSPC SP 1, Solvent Cleaning.
 6. SSPC SP 3, Power Tool Cleaning.
 7. SSPC SP 6, Commercial Blast Cleaning.
 8. SSPC SP 10, Near-White Blast Cleaning.
 9. SSPC SP 11, Power Tool Cleaning To Bare Metal.
 10. SSPC VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
 11. SSPC VIS 2, Method of Evaluating Degree of Rusting/Painted Steel Surfaces.
 12. SSPC Volume 2, Systems and Specifications.

1.3 DEFINITIONS

- A. Standard coating terms defined in ASTM D16 apply to this Section, including:
1. Paint: Pretreatment and all painting system materials, such as primer, emulsion, enamel, organic/inorganic polymer coating, stain sealer and filler, and other applied materials whether used as prime, filler, intermediate, or finish coats.
 2. Exposed: All items not covered with cement plaster, concrete, or fireproofing. Items covered with these materials shall be provided with specified primer only, except where specified as a surface not to be painted. Exposed-to-view surfaces include areas visible after permanent or built-in fixtures, convactor covers, ceiling tile, covers for finned tube radiation, grilles, and similar covering products are in areas scheduled to be painted.
 3. Low VOC: All interior and exterior field-applied coatings that have maximum VOC content as listed in OTC Model Rule for Architectural and Industrial Maintenance Coatings.
 4. OTC: Ozone Transport Commission, which recommends standard VOC content levels in several Northeastern and Mid-Atlantic states.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications:
1. Engage a single applicator that regularly performs installation of paint materials, with documented skill and successful experience in installing types of products required and that agrees to employ only trained, skilled tradesmen who have successful experience in installing types of products specified.
 2. Submit name and qualifications to ENGINEER along with following information for at least three successful, completed projects:
 - a. Names and telephone numbers of owner and design professional responsible for project.
 3. Submit to ENGINEER proof of acceptability of applicator by manufacturer.

B. Source Quality Control:

1. Obtain materials from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work, to advise on products, mock-ups, installation, and finishing techniques and, at completion of Work, to advise ENGINEER on acceptability of completed Work and during the course of the Work as may be requested by ENGINEER.
2. Certify long-term compatibility of all coatings with surfaces.
3. Do not submit products that decrease number of coats, surface preparation, or generic type and formulation of coatings specified. Products exceeding VOC limits and chemical content specified will not be approved.
4. ENGINEER may review manufacturers' recommendations concerning methods of installation and number of coats of paint for each painting system. CONTRACTOR shall prepare construction costs based on painting systems, number of coats, coverage's and installation methods specified.
5. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and recoatability after curing.
6. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in all painting systems.
7. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services to be painted. Comply with:
 - a. Lead and Chromate: Lead and chromate content shall not exceed amount permitted by authorities having jurisdiction.
 - b. Areas subject to hydrogen sulfide fume exposure will be identified by ENGINEER. Through CONTRACTOR, paint manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in such areas.
 - c. Manufacturer shall identify colors that meet the requirements of authorities having jurisdiction at Site for use in locations subject to contact with potable water or water being prepared for use as potable water.
 - d. Comply with paint manufacturer's recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint.
8. Obtain each product from one manufacturer. Multiple manufacturing sources for the same system component are unacceptable.
9. Certify product shelf life history for each product source for materials manufactured by the same manufacturer, but purchased and stored at different locations or obtained from different sources.
10. Constantly store materials to be used for painting Work between 60 degrees F and 90 degrees F, and per paint manufacturer's written recommendations, for not more than six months. Certify to ENGINEER that painting materials have been manufactured within six months of installation and have not, nor will be, subjected to freezing temperatures.

C. Regulatory Requirements:

1. Painting systems for surfaces in contact with potable water, or water being treated for potable use, shall not impart any taste or odor to the water or result in any organic or inorganic content in excess of the maximum allowable contaminant level established by authorities having jurisdiction at Site. Such painting systems shall be approved by the regulatory agency. Revise painting systems specified herein to provide manufacturer's regulatory agency approved painting system(s) where required.
2. Comply with VOC content limits of OTC Model Rule for Architectural and Industrial Maintenance Coatings:
 - a. Industrial Maintenance Coatings: 340 grams per liter.
 - b. Interior and Exterior Non-Flat Coatings: 250 grams per liter.
3. Comply with the following:
 - a. 29 CFR 1910.144, Safety Color Code for Marking Physical Hazards.
 - b. 40 CFR, Subpart D-2001, National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - c. Resource Conservation and Recovery Act of 1976 (RCRA).
 - d. SW-846, Toxic Characteristic Leaching Procedure (TCLP).
4. Comply with authorities having jurisdiction at Site for blast cleaning, confined space entry, and disposition of spent abrasive and debris.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:
 - a. Copies of manufacturer's technical information and test performance data, including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contract Documents, and application instructions for each product proposed for use.
 - b. Submit proof of acceptability of proposed application techniques by paint manufacturer selected.
 - c. Copies of CONTRACTOR's proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and painting Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.
 - d. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.
 - e. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.
 - f. Specification for spray equipment with cross-reference to paint manufacturer's recommended equipment requirements.

2. Samples:
 - a. Copies of manufacturer's complete color charts for each coating system.
- B. Informational Submittals: Submit the following:
 1. Certificates:
 - a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.
 - b. Evidence of shelf life history for all products verifying compliance with the requirements of the Contract Documents.
 2. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.
 3. Qualifications:
 - a. Applicator.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Product Delivery Requirements: Deliver products to Site in original, new, and unopened packages and containers, accurately and legibly and accurately labeled with the following:
 1. Container contents, including name and generic description of product.
 2. Manufacturer's stock number and date of manufacture.
 3. Manufacturer's name.
 4. Contents by volume, for major pigment and vehicle constituents.
 5. Grams per liter of volatile organic compounds.
 6. Thinning instructions, where recommended.
 7. Application instructions.
 8. Color name and number.
- B. Product Storage Requirements:
 1. Store acceptable materials at Site.
 2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
 3. Store products that are not in actual use in tightly covered containers.
 4. Comply with health and fire regulations of authorities having jurisdiction at Site.
- C. Product Handling Requirements:
 1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.
 2. Do not open containers or mix components until necessary preparatory work has been completed and approved by ENGINEER and painting Work will start immediately.
 3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.7 SITE CONDITIONS

A. Site Facilities:

1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system application, are not available at Site.
2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance and temperature monitoring personnel is responsibility of CONTRACTOR.
3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent such heat sources to exterior such that paint systems are unaffected by exhaust.

B. Existing Conditions:

1. Existing surfaces to receive painting Work shall be surface-prepared to meet requirements of painting systems specified. Prior to commencing painting Work, perform adhesion tests on existing surfaces to be painted. Perform testing per ASTM D4541 or other method acceptable to ENGINEER. Number and location of tests shall be sufficient to determine condition of existing coatings and suitability of existing coatings to remain to provide acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER a copy of adhesion test results.
2. Provide abrasive blasting, scraping, or other abrading or surface film removal, or preparatory techniques accepted by ENGINEER.
3. Before commencing painting in an area, surfaces to be painted and floors shall be cleaned of dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air (HEPA) filters and dust containment systems.

C. Environmental Requirements:

1. Surfaces to be painted shall be at least 5 degrees F above dew point temperature and be dry to the touch. Apply paint only when temperature of surfaces to be painted, paint products, and ambient air temperatures are between 65 degrees F and 95 degrees F, unless otherwise permitted by paint manufacturer's published instructions.
2. Apply paint system within shortest possible time consistent with manufacturer's recommended curing instructions for each coat. If chemical, salt, or other contamination contacts paint film between coats, remove contamination per SSPC SP 1 and restore surface before applying paint.
3. Do not apply epoxy paints if ambient temperature is expected to go below 50 degrees F within twelve hours of application. Follow manufacturer's instructions when manufacturer's published recommendations require a higher minimum ambient temperature.
4. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent. Do not apply paint to damp or wet surfaces or when surfaces will reach dew point due to falling or rising temperatures and humidity conditions during course of paint application, unless otherwise permitted by paint manufacturer's published instructions.

5. Do not paint unacceptably hot or cold surfaces until such surfaces can be maintained within temperature and dew point ranges acceptable to paint manufacturer. Arrange for surfaces to be brought within acceptable temperature and dew point ranges as part of painting Work.
6. Moisture content of surfaces shall be verified to ENGINEER as acceptable prior to commencement of painting using methods recommended by paint manufacturer.
7. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer for application and drying.
8. Provide adequate illumination and ventilation where painting operations are in progress.

D. Protection:

1. Cover or otherwise protect finished work of other trades and surfaces not being painted concurrently, or not to be painted.
2. When working with flammable materials, provide fire extinguishers and post temporary signs warning against smoking and open flame.

PART 2 - PRODUCTS

2.1 PAINTING SYSTEM MANUFACTURERS

- A. Products and Manufacturers: Where referenced under painting systems provide products manufactured by the following:
1. Tnemec Company, Inc. (TCI).
 2. The Carboline Company, part of StonCor Group, an RMP Company (TCC).
 3. Sherwin-Williams Company (SWC).

2.2 PAINTING SYSTEMS

- A. New and Existing Ferrous Metals, Non-Ferrous Metals, and Galvanized Metals; Low VOC Content, Non-Submerged, Exterior:
1. Surface Preparation: Refer to Paragraphs 3.2.A., 3.2.B.1., 3.2.B.2., and 3.2.C.
 2. Ferrous Metal Primer:
 - a. Generic Components:
 - 1) Minimum 67 percent volume solids, build, two-component, cycloaliphatic amine-catalyzed epoxy coating; 250 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series V69 Hi-Build Epoxoline (TCI); Carboguard 890 LT (TCC); Macropoxy HS (SWC): One coat, 4.0 to 6.0 dry mils.
 3. Ferrous Metal Touch-Up:
 - a. Generic Components:
 - 1) For Low-temperature Curing Conditions: Minimum 80 percent solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum.

- 2) For Warm-temperature Curing Conditions: Minimum 80 percent volume solids, modified polyamido-amine or polyamine epoxy; 296 grams per liter VOC, maximum.
- b. Products and Manufacturers: Provide one of the following:
 - 1) For Low-temperature Curing Conditions: Series 136, Chembuild FC (TCI); Carboguard 890 LT (TCC); Macropoxy HS Epoxy (SWC): One coat, 10.0 dry mils.
 - 2) For Warm-temperature Curing Conditions: Series 166 Epoxoline HS (TCI); Carboguard 1207 HB (TCC); Macropoxy HS Epoxy (SWC): One coat, 6.0 dry mils.
4. Galvanized and Non-Ferrous Primer.
 - a. Generic Components:
 - 1) Refer to Paragraph 2.2.A.2.a.1), above.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Refer to Paragraph 2.2.A.2.b.1), above.
5. Intermediate – Ferrous Metals Only:
 - a. Generic Components:
 - 1) Refer to Paragraph 2.2.A.3.a.1), above.
 - 2) Refer to Paragraph 2.2.A.3.a.1), above.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Refer to Paragraph 2.2.A.3.a.1), above.
 - 2) Refer to Paragraph 2.2.A.3.b.1), above.
6. Finish: Gloss:
 - a. Generic Components:
 - 1) Minimum 49 percent volume solids, two-component, waterborne acrylic polyurethane or aliphatic acrylic polyurethane coating; 247 grams per liter VOC, maximum.
 - b. Products and Manufacturers: Provide one of the following:
 - 1) Series 1080 Endura-Shield WB (TCI); Carbothane 134 VOC (TCC); Centurion WB Urethane (SWC): Two coats, 2.0 to 3.0 dry mils.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which painting Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film capable of performing in accordance with claims made in paint manufacturer's product literature for surfaces and conditions encountered.

- C. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for long-term adherence and durability of painting systems specified or where paint manufacturer requires removal of all existing paint to recommend use of specified painting system.

3.2 SURFACE PREPARATION

A. General:

1. Test for moisture content of surfaces before commencement of painting Work. Test for moisture in concrete in compliance with ASTM D4263. Report results to ENGINEER before commencing Work.
2. Perform preparation and cleaning procedures as specified herein and in strict accordance with paint manufacturer's approved instructions for each surface and atmospheric condition.
3. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items already in place that do not require field painting, or provide effective surface-applied protection prior to surface preparation and painting.
4. Remove as necessary items that must be field-painted where adjacent surfaces cannot be completely protected from splatter or overspray. Following completion of painting of each space or area, the removed items shall be reinstalled by workers skilled in the trades involved.
5. Clean surfaces to be painted before applying painting system components. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning.
6. Prepare surfaces that were improperly shop-painted and abraded or rusted shop-painted surfaces as specified.

B. Ferrous Metals:

1. Ferrous Metals Except Ductile and Cast Iron:
 - a. Comply with paint manufacturer's recommendations for type and size of abrasive to provide a surface profile that meets manufacturer's painting system requirements for type, function, and location of surface. Verify that paint manufacturer-recommended profiles have been achieved on prepared surfaces. Report profiles to ENGINEER using Test Method C of ASTM D4417.
 - b. Clean non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed, of all oil, grease, dirt, mill scale, and other contamination by commercial blast cleaning complying with SSPC SP 6 at time of paint system application, using SSPC VIS 1 as a standard of comparison.
 - c. Clean submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed of all oil, grease, dirt, mill scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.

- d. Clean non-submerged, ferrous surfaces that have not been shop-coated of all oil, grease, dirt, loose mill scale, and other contamination by commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison.
 - e. Clean submerged ferrous surfaces that have not been shop-coated or that have been improperly shop-coated of all oil, grease, dirt, mill scale, and other contamination by near-white blasting complying with SSPC SP 10 at time of painting system application, using SSPC VIS 1 as a standard of comparison.
 - f. Touch-up shop-applied prime coats that have damaged or have bare areas with primer recommended by paint manufacturer after commercial blasting complying with SSPC SP 6 at the time of painting system application, using SSPC VIS 1 as a standard of comparison, to provide a surface profile of not less than one mil.
 - g. Power tool-clean per SSPC SP 3 to remove welding splatter and slag.
 - h. Remove all rust and contamination on existing ferrous metals to sound surfaces by power tool-cleaning complying with SSPC SP 11 to provide a surface profile of not less than one mil.
2. Ductile and Cast Iron:
- a. Comply with paint manufacturer's recommendations and NAPF 500-03 for type and size of abrasive to provide a surface profile meeting paint manufacturer's requirements for type, function and location of surface. Verify that paint manufacturer-recommended profiles are achieved on prepared surfaces.
 - b. Clean submerged ductile and cast iron that have not been shop-coated or that have been improperly shop-coated of all oil, grease, dirt, mill scale, and other contamination by solvent cleaning and abrasive blasting complying with NAPF 500-03-01, NAPF 500-03-04, and NAPF 500-03-05 at time of paint system application.
 - c. Touch-up shop-applied prime coats that are damaged or have bare areas with primer recommended by paint manufacturer, after power tooling complying with NAPF 500-03 at the time of painting system application.
 - d. Remove all contamination on existing ductile and cast iron to sound surfaces by power tool cleaning complying with NAPF 500-03-03.

C. Galvanized (Zinc-Coated) Surfaces: Prepare galvanized surfaces for painting by lightly sanding with 60- to 80-mesh sandpaper or by light whip blasting.

3.3 MATERIALS PREPARATION

A. General:

- 1. Mix and prepare paint products in strict accordance with paint manufacturer's product literature.
- 2. Do not mix painting materials produced by different manufacturers, unless otherwise permitted by paint manufacturer's instructions.
- 3. Where thinners are required, they shall be produced by paint system manufacturer unless otherwise permitted by paint manufacturer's product literature and submitted to and accepted by ENGINEER with Shop Drawings.

B. Tinting:

1. Where multiple coats of the same material are to be provided, tint each undercoat a lighter shade to facilitate identification of each coat of paint.
2. Tint undercoats to match color of finish coat of paint, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide a code number to identify material tinted by manufacturer.

C. Mixing:

1. For products requiring constant agitation, use methods in compliance with manufacturer's product literature to prevent settling during paint application.
2. Mix in containers placed in suitably sized non-ferrous or oxide resistant metal pans to protect floors from slashes or spills that could stain the floor or react with subsequent finish floor material.
3. Mix and apply paint in containers bearing accurate product name of material being mixed or applied.
4. Stir products before application to produce a mixture of uniform density and as required during the application. Do not stir into the product film that forms on surface; instead, remove film and, if necessary, strain product before using.
5. Strain products requiring such mixing procedures. After adjusting mixer speed to break up lumps and after components are thoroughly blended, strain through 35 to 50-mesh screen before application.

3.5 APPLICATION

A. General:

1. Apply paint systems by brush, roller, or airless spray per manufacturer's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Volume 2, where applicable. Use brushes best suited for type of paint applied. Use rollers of carpet, velvet back, or high pile sheeps wool as recommended by paint manufacturer for product and texture required. Use air spray and airless spray equipment recommended by paint manufacturer for specific painting systems specified. Submit a list of application methods proposed, listing paint systems and location.
2. Paint dry film thicknesses required are the same regardless of the application method. Do not apply succeeding coats until previous coat has completely dried.
3. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is uniform finish, color, and appearance, particularly for intense chroma primary colors. Ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a film thickness equivalent to that of flat surfaces.
4. Surfaces of items not normally exposed-to-view do not require the same color as other components of system of which they are part, but require the same painting system specified for exposed surfaces of system.
5. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint shop-primed coats and pre-finished items only when approved by ENGINEER using compatible primers and manufacturer's recommended compatible field-applied finishes.

- B. Minimum/Maximum Paint Film Thickness:
1. Apply each product at not less than, nor more than, manufacturer's recommended spreading rate, and provide total dry film thickness as specified.
 2. Apply additional coats of paint if required to obtain specified total dry film thickness.
 3. Maximum dry film thickness shall not exceed 100 percent of minimum dry film thickness, except where more stringent limitations are recommended by paint manufacturer for a specific product.
- C. Scheduling Surface Preparation and Painting:
1. As soon as practical after preparation, apply first-coat material to surfaces that have been cleaned, pretreated, or otherwise prepared for painting. Apply first-coat material before subsequent surface deterioration due to atmospheric conditions existing at time of surface preparation and painting. Surfaces that have started to rust before first-coat application is complete shall be brought back to required standard by abrasive blasting.
 2. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure and application of another coat of paint does not cause lifting or loss of adhesion to undercoat.
 3. Scarify primers and other painting system components by brush-blasting if paint has been exposed for lengths of time or under conditions beyond manufacturer's written recommendations for painting systems required, intended use, or method of application proposed for subsequent coats of paint.
 4. Schedule cleaning and painting so that dust and other contaminants from cleaning process do not fall on wet, newly painted surfaces.
- D. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.
- E. Brush Application:
1. Brush out and work all brush coats onto surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
 2. Brush-apply primer or first coats, unless otherwise permitted to use mechanical applicators.
- F. Mechanical Applicators:
1. Use mechanical methods for paint application when permitted by governing ordinances, manufacturer, and approved by ENGINEER.
 2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide the equivalent hiding as brush-applied coats.
 3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of multiple coats in one pass.

- G. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

3.4 FIELD QUALITY CONTROL

- A. Notify ENGINEER after completing each coat of paint. After inspection and checking of film thickness, and imperfections, and after acceptance by ENGINEER, proceed with succeeding coat.
 - 1. ENGINEER will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
 - 2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.
- B. For magnetic substrates, measure thickness of dry film nonmagnetic coatings following recommendations of SSPC PA-2. These procedures supplement manufacturers' approved instructions for manual operation of measurement gauges and do not replace such instructions.
- C. Record time, location, number of coats, dry film thickness, and imperfections and submit testing results to ENGINEER.

3.5 PROTECTION OF NEW FINISHES

- A. Provide signs that read, "Wet Paint" as required to protect newly painted finishes. Remove temporary wrappings provided for protection of the Work after completion of painting.

3.6 ADJUSTING AND CLEANING

- A. Correct damages to work of other trades through cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.
- B. During progress of Work, remove from Site all discarded paint materials, rubbish, cans, and rags at end of each workday.
- C. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, while avoiding scratching or otherwise damaging finished surfaces.
- D. At completion of work of other trades, touch-up and restore damaged or defaced painted surfaces as determined by ENGINEER.

3.7 SCHEDULES

- A. The schedules listed below, following the “End of Section” designation, are a part of this Specification section.
1. Table 09 91 00-C, Painting Schedule.

++ END OF SECTION ++

**TABLE 09 91 00-C
PAINTING SCHEDULE**

Facility or Surface *	Painting System **
Guard Posts	A
Station N Wet Well Vent	A

* Refer to Drawings for facility locations and for facilities not listed above.

** Refer to Article 2.2 of this Section.

SECTION 26 05 05

GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to complete the electrical Work.
2. Demolition: Electrical demolition shall be in accordance with Section 02 41 00, Demolition.
3. Demolition: Responsibility for electrical demolition is indicated in Section 01 11 13, Summary of Work.

B. Coordination:

1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.
2. Coordination and Intent of Electrical Drawings:
 - a. Dimensions on Drawings related to equipment are based on equipment of certain manufacturers. Verify the dimensions of equipment furnished to space available at the Site and allocated to the equipment.
 - b. Drawings show the principal elements of the electrical Work and are not intended as detailed working drawings for the electrical Work. Drawings supplement and complement the Specifications and other Contract Documents relative to principal features of electrical systems.
 - c. Equipment and devices provided under this Contract shall be properly connected and interconnected with other equipment and devices for successful operation of complete systems, whether or not all connections and interconnections are specifically mentioned or shown in the Contract Documents.
 - d. Drawings are provided for CONTRACTOR's guidance in fulfilling the intent of the Contract Documents CONTRACTOR shall comply with Laws and Regulations, including safety and electrical codes, and provide materials, equipment, appurtenances, and specialty items necessary for complete and operable systems.
3. Field Coordination:
 - a. Provide materials, equipment, and services to interface with existing circuits. Field-verify system and equipment requirements prior to modifying existing systems.
 - b. Coordinate the interface of equipment with OWNER's personnel and field conditions.

C. Related Sections:

1. Section 02 41 00, Demolition.

D. Area Classifications:

1. Materials, equipment, and incidentals shall be suitable for the area classification(s) shown, specified, and required.
2. Wet Locations: Comply with NEC and NEMA requirements for wet locations. Enclosures in wet locations shall comply with NEMA 4 unless specified otherwise.
3. Corrosive Locations: Comply with NEC and NEMA requirements for corrosive locations. Enclosures in corrosive locations shall conform to NEMA 4X requirements unless specified otherwise.
4. Hazardous Locations: Comply with NEC requirements for the Class and Division designated.
5. Dusty Locations: Indoor areas not designated as hazardous, corrosive, or wet are dusty locations. Comply with NEC and NEMA 12 requirements unless specified otherwise.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Electrical Subcontractor:
 - a. Electrical Subcontractor shall have not less than five years of experience installing electrical systems of the types required for the Project.
 - b. Electrical Subcontractor shall possess a valid electricians' and contractors' license in the jurisdiction where the Site is located.

B. Component Supply and Compatibility:

1. Materials and equipment similar to each other shall be from the same manufacturer for uniformity.

C. Regulatory Requirements:

1. Permits: Refer to the General Conditions, Supplementary Conditions, and other parts of the Contract Documents for responsibilities relative to obtaining and paying for permits, licenses, and inspection fees.
2. Codes: Refer to Section 01 42 00, References, for indication of applicable codes.

1.3 SUBMITTALS

A. General:

1. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section into the smallest number of submittals possible. Do not furnish partial submittals.
2. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.

- B. Action Submittals: Submit the following:
1. Shop Drawings:
 - a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
 - b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting and grounding.
 - c. Point-to-point interconnection wiring diagrams.
 2. Product Data:
 - a. Manufacturer's name and product designation or catalog number.
 - b. Electrical ratings.
 - c. Manufacturer's technical data and specifications.
 - d. Painting and coating systems proposed.
 3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing and field quality control testing.
- C. Informational Submittals: Submit the following:
1. Manufacturer's Instructions:
 - a. Installation data and instructions.
 - b. Instructions for handling, start-up, and troubleshooting.
- D. Closeout Submittals: Submit the following:
1. Record Documentation:
 - a. System Record Drawings: Include the following:
 - 1) One-line wiring diagram of the electrical distribution system.
 - 2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
 - 3) Layouts of the power and lighting arrangements and the grounding system.
 - 4) Control schematic diagrams, with terminal numbers and control devices identified, for all equipment.
 - b. Record documents shall indicate final equipment and field installation information.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Performance Criteria:
1. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, with ambient outside air temperature of -30 degrees F to 120 degrees F and an elevation of 1000 feet above mean sea level.
 2. Unless specified otherwise, electrical equipment shall have ratings based on 75 degrees C terminations.
- B. Testing Laboratory Labels: Electrical material and equipment shall bear the label of Underwriters' Laboratories, Inc. or other nationally recognized, independent testing laboratory, where standards have been established and label service applies.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. General:
 - 1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
 - 2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
 - 3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.
- B. Staging, Sequencing, and Coordination with Existing Facilities:
 - 1. Schedule, sequence, and install materials and equipment in accordance with Section 01 14 16, Coordination with Owner's Operations
 - 2. When operation of existing facilities and Site is disrupted due to CONTRACTOR's operations, comply with Section 01 14 16, Coordination with Owner's Operations, unless otherwise allowed by OWNER.
 - 3. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of OWNER and ENGINEER.
 - 4. Interruptions of existing circuits, not addressed in Section 01 14 16, Coordination with Owner's Operations, shall be coordinated with the OWNER who will determine the length of time a circuit may be de-energized to maintain the OWNER's processes in dependable and safe operation.

3.3 FIELD QUALITY CONTROL

- A. Field Quality Control – General:
 - 1. Perform field quality control for electrical Work in accordance with the Contract Documents.
- B. Site Tests:
 - 1. Perform the following operational tests on electrical systems:
 - a. Remove and re-apply power supply to automatic transfer equipment to verify operation. Activate standby power systems to verify their automatic start-up, proper de-energization, and cool down upon resumption of normal power supply.

- b. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.
- C. Manufacturer's Services:
 - 1. Furnish at the Site qualified, factory-trained representative(s) of equipment manufacturers for the services indicated in the Contract Documents.

+ + END OF SECTION + +

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling.
 - 2. Types of cabling required include:
 - a. Insulated cable for installation in raceways.
 - b. Direct-burial cable.
- B. Related Sections:
 - 1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - 2. ASTM B3, Specification for Soft or Annealed Copper Wire.
 - 3. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 300, Wiring Methods.
 - 2. NEC Article 310, Conductors for General Wiring.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's literature, specifications, and engineering data for low volt insulated cable proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Insulated Cable In Raceways:

1. Application: Use for circuits located indoors and outdoors.
2. Manufacturers: Provide products of one of the following:
 - a. Southwire.
 - b. The Okonite Company.
 - c. American Insulated Wire
 - d. General Cable
 - e. Or equal.
3. Material: Single conductor copper cable complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW-2 or RHW-2 complying with UL 44. Multiconductor control cable shall utilize in dry or wet locations, listed by UL as Type THWN or as noted on the drawings.
4. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
5. Stranding: 600-volt cable shall be stranded, except that solid cable, No. 10 and smaller may be used for lighting circuits.

B. Cable Connectors, Solderless Type:

1. Products and Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Hylug.
 - c. Or equal.
2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
3. For wire sizes up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.

C. Cable Splices:

1. Products and Manufacturers:
 - a. Compression-Type Splices: Provide one of the following:
 - 1) Burndy Hylink.
 - 2) T&B Color-Keyed Compression Connectors.
 - 3) Or equal.
 - b. Spring Connectors: Provide one of the following:
 - 1) Buchanan B-Cap.
 - 2) T&B Wire Connector.
 - 3) Or equal.

2. For wire sizes No. 8 AWG and larger, splices shall be made up with compression type copper splice fittings. Splices shall be taped and covered with materials recommended by cable manufacturer to provide insulation equal to that on conductors.
3. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
4. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
5. Splices shall be suitably sized for cable, rated 90 degrees C, and 600 volts.

D. Wire and Cable Markers:

1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation.
- B. Pulling:
 1. Use insulating types of pulling compounds containing no mineral oil.
 2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
 3. Use dynamometer where mechanical means are used.
 4. Cut off section subject to mechanical means.
- C. Bending Radius: Limit to minimum of six times cable overall diameter.
- D. Slack: Provide maximum slack at all terminal points.
- E. Splices:
 1. Where possible, install cable continuous, without splice, from termination to termination.
 2. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof.
 3. Splices are not allowed in conduits.
- F. Identification:
 1. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
 2. Identify power conductors by circuit number and phase at each terminal or splice location.
 3. Identify control and status wiring using numeral tagging system.

G. Color-code power cables as follows:

1. No. 8 AWG and Smaller: Provide colored conductors.
2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
120/240 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
120/240 Volts Three-Phase, Four-Wire Delta, Center Tap Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	rounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

3.2 FIELD QUALITY CONTROL

A. Site Tests:

1. Test each electrical circuit after permanent cables are in place, to demonstrate that circuit and equipment are connected properly and will perform satisfactorily, free from improper grounds and short circuits.

++ END OF SECTION ++

SECTION 26 05 23

INSTRUMENTATION AND COMMUNICATION CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
 - 2. Types of cables include the following:
 - a. Shielded instrumentation cables.
 - b. Data communication cables.
- B. Related Sections:
 - 1. Section 26 05 33.13, Rigid Conduits.
 - 2. Section 26 05 53, Identification for Electrical Systems.

1.2 TERMINOLOGY

- A. The following words or terms are not defined but, when used in this Section, have the following meaning:
 - 1. “CPE” means chlorinated polyethylene.
 - 2. “FEP” means fluorinated ethylene-propylene.
 - 3. “XLPE” means cross-linked polyethylene.

1.3 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
 - 2. TIA/EIA-485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems (known as RS-485).
 - 3. UL 13, Power-Limited Circuit Cables.
 - 4. UL 1581, Electrical Wires, Cables and Flexible Cords.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
 - 2. NEC 800, Communications Circuits.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.
- B. Informational Submittals: Submit the following:
 - 1. Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. Cables shall bear the UL label.
- B. Single Shielded Pair Instrument Cables:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 - 2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581.
- C. Multi-Paired Shielded Instrument Cables:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.
 - 2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, twisted pairs with shield over each pair, stranded tinned no. 18 AWG copper drain wire, and overall PVC or CPE outer jacket. Rated for not less than 600 volts and complying with either UL 1581 or UL 13.
- D. Multi-Conductor Shielded Instrument Cables:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Belden Company.
 - b. Okonite Company.
 - c. Dekoron Wire and Cable Company.
 - d. Or equal.

2. Tinned copper, XLPE-insulated stranded conductors, not less than no. 16 AWG, stranded tinned no. 18 AWG copper drain wire, with overall 100 percent foil shield and overall PVC or CPE jacket. Rated for not less than 600 volts.

E. Cable Terminals:

1. Manufacturers: Provide products of one of the following:
 - a. T&B Sta-Kon.
 - b. Burndy Insulug.
 - c. Or equal.
2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

F. Cable Support Hardware:

1. Conduit:
 - a. All wiring shall be installed in conduit and shall comply with Section 26 05 33.13, Rigid Conduits.

G. Modbus Cables (RS-232):

1. Products and Manufacturers:
 - a. Non-Plenum-Rated Modbus Cables: Provide one of the following:
 - 1) Belden 8777.
 - 2) Or equal.
 - b. Plenum-Rated Modbus Cables: Provide one of the following:
 - 1) Belden 88777.
 - 2) Or equal.
2. Cables shall consist of six tinned copper, no. 22 AWG, stranded conductors, polypropylene-insulated, twisted into three pairs, each pair individually shielded with 100-percent aluminum-polyester shield, one no. 22 AWG, stranded, tinned copper drain wire per pair, covered with an overall PVC jacket.
3. Where plenum rating is required, cable insulation and jacket shall be FEP in lieu of insulation and jacket materials otherwise specified in this Section for Modbus cables.
4. When portion of cable run is not contained in conduit or appropriate enclosure, cable shall be plenum- or riser-listed and marked in accordance with NEC 800.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:

1. Install cables complete with proper terminations at both ends.
2. Install in conduit separate from power cables, unless shown or indicated otherwise.
3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.
4. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
6. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

A. Site Tests:

1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
3. Replace with new cables the full length of cables that fail test.
4. Test equipment shall be provided by CONTRACTOR.
5. For testing of communications cables, test equipment used shall comply with the following:
 - a. Equipment shall consist of a "master" and a "remote" unit.
 - b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
 - c. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.

+ + END OF SECTION + +

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems, structures, and equipment.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
 - 2. ASTM B8, Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
 - 3. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements
 - 1. National Electrical Code, (NEC).
 - a. NEC Article 250, Grounding and Bonding.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's technical information for grounding materials proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Bare Ground Cable:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Cablec Corporation.
 - b. General Cable Corporation.
 - c. Southwire Cable Company.
 - d. Or equal.
 - 2. Material: Soft-drawn, bare copper stranded cable complying with ASTM B8. No. 4/0 AWG minimum size unless otherwise shown or indicated on the Drawings.

B. Ground Rods:

1. Manufacturers: Provide products of one of the following:
 - a. Copperweld, Bimetallics Division.
 - b. ITT Blackburn Company.
 - c. Or equal.
2. Material: Copper-clad rigid steel rods, 3/4-inch diameter, ten feet long.

C. Grounding Connectors:

1. Products and Manufacturers: Provide one of the following:
 - a. Pressure Connectors:
 - 1) O.Z./Gedney, Division of General Signal Corporation.
 - 2) Burndy Corporation.
 - 3) Or equal.
 - b. Welded Connections:
 - 1) Cadweld by Erico Products, Incorporated.
 - 2) Therm-O-Weld by Burndy Corporation.
 - 3) Or equal.
2. Material: Pressure connectors shall be copper alloy castings, designed and fabricated specifically for items to be connected and assembled with Durium or silicone bronze bolts, nuts, and washers. Welded connections shall be by exothermic process utilizing molds, cartridges, and hardware designed specifically for connection to be made.

D. Ground system components shall comply with UL 467.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions for the Work and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 EQUIPMENT GROUNDING

- A. Ground electrical equipment in compliance with Laws and Regulations and the Contract Documents.
- B. Equipment grounding conductors shall be bare stranded copper cable of adequate size installed in metal conduit where required for mechanical protection. Ground conductors, pulled into conduits with non-grounded conductors, shall be insulated. Insulation shall be green.
- C. Control panels grounding conductors shall be bare stranded copper cable of adequate size to ground grid from AC ground bus, and an insulated stranded copper cable of adequate size to ground grid from DC ground bus.

- D. Connect ground conductors to conduit with copper clamps, straps, or with grounding bushings.
- E. Connect to piping by welding or brazing. Use copper bonding jumpers on gasketed joints.
- F. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use hold-down bolts. Where grounding provisions are not included, drill suitable holes in locations recommended by equipment manufacturer or designated by ENGINEER.
- G. Connect to motors by bolting directly to motor frames, not to soleplates or supporting structures.
- H. Connect to service water piping by means of copper clamps. Use copper bonding jumpers on gasketed joints.
- I. Scrape bolted surfaces clean and coat with conductive oxide-resistant compound.

3.3 FIELD QUALITY CONTROL

- A. Site Tests:
 - 1. Test completed grounding systems for resistance to ground using an electrical three-terminal ground resistance tester. Test all grounded cables and metal parts for continuity of connection. OWNER will witness the testing.

+ + END OF SECTION + +

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports for electrical systems.
 - 2. Area Classifications: Materials shall be suitable for the area classification(s) shown or indicated on the Drawings, and specified in Section 26 05 05, General Provisions for Electrical Systems.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 33.13, Rigid Conduits.

1.2 REFERENCES

- A. Standards referenced in this section are:
 - 1. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 2. ASTM A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's name, product designation, and catalog number of each material item proposed for use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. B-Line.
 - 2. Kindorf.
 - 3. Unistrut
 - 4. Or equal.

2.2 MATERIALS

A. Strut, Fittings, and Accessories:

1. General
 - a. Unless otherwise shown or indicated, strut shall be 1-5/8 inches by 1-5/8 inches. Double struts shall be two pieces of the same strut, welded back-to-back at the factory.
 - b. Attachment holes, when required, shall be factory-punched on hole centers approximately equal to the cross-sectional width and shall be 9/16-inch diameter.
 - c. Fittings, braces, brackets, hardware, and accessories shall be Type 316 stainless steel.
 - d. Strut nuts shall be spring captured Type 316 stainless steel.
 - e. Square and round washers shall be Type 316 stainless steel.
2. Strut materials shall be suitable for area classifications indicated in Section 26 05 05, General Provisions for Electrical Systems, and shown or indicated on the Drawings.
 - a. Dusty Locations:
 - 1) Strut shall be 12-gage carbon steel, hot-dip galvanized after fabrication, complying with ASTM A123/A123M.
 - b. Wet Locations:
 - 1) Strut shall be 12-gage Type 316 stainless steel.
 - c. Corrosive Locations:
 - 1) Strut shall be 12-gage Type 316 stainless steel.

B. Hanger Rods:

1. Material:
 - a. Dry Locations: All-thread, zinc-coated
 - b. Wet, Corrosive, or Hazardous Areas: Stainless steel.
2. Size: Not less than 3/8-inch diameter, unless otherwise shown on the Drawings or specified.

C. Beam Clamps for Attaching Threaded Rods or Bolts to Beam Flanges for Hanging Struts or Conduit Hangers:

1. Beam clamps shall be stainless steel equipped with stainless steel square-head set screw, and shall include threaded hole sized for attaching the all-thread rod or threaded bolt.

D. Miscellaneous Hardware:

1. Bolts, screws, and washers shall be stainless steel.
2. Hex Nuts: Shall be stainless steel and include nylon inserts.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Provide hangers and supports for electrical systems with necessary channels, fittings, brackets, and related hardware for mounting and supporting materials and equipment. Provide anchor systems, concrete inserts, and associated hardware for proper support of electrical systems.
- B. Install equipment and devices on hangers and supports as shown on the Drawings, as specified, and as required.
- C. Install hangers and supports level, true, free of rack, and parallel and perpendicular to building walls and floors, so that the hangers and supports are installed in a neat, professional, workmanlike manner.
- D. Coordinate installation of hangers and supports with equipment, cabinets, consoles, panels, enclosures, boxes, conduit, cable tray, wireway, busway, cablebus, piping, ductwork, lighting fixtures, and other systems and equipment. Locate hangers and supports clear of interferences and access ways.
- E. Anchor Bolts, Expansion Anchors, and Concrete Inserts: Shall be in accordance with Section 05 05 33, Anchor Systems, and requirements of this Section.
- F. Mounting of Conduit:
 - 1. Provide space of not less than 1/4-inch between conduit surfaces and abutting or near surfaces except struts, cable trays, steel beams, and columns.
 - 2. Fasten conduit to struts, cable trays, steel beams, and columns using specified clamps and straps as shown, specified, and required.
 - 3. Devices shall be compatible with size of conduit and type of support. Following installation, size identification shall be visible and legible.
 - 4. Install conduit supports and fasteners in accordance with Section, 26 05 33.13, Rigid Conduits.
- G. Supports for Cabinets, Consoles, Panels, Enclosures, and Boxes:
 - 1. Freestanding: Unless otherwise specified or shown on the Drawings, provide supports for floor-mounted equipment, cabinets, consoles, panels, enclosures, and boxes. Such supports shall be 3.5-inch high concrete equipment base with a 45 degree chamfered edge. Base shall extend two inches beyond outside dimensions of equipment on all sides.

2. Wall-Mounted:
 - a. Provide space not less than 1/4-inch between cabinets, consoles, panels, enclosures, and boxes and the surface on which each is mounted. Provide non-metallic or stainless steel spacers as required.
 - b. Do not mount equipment, enclosures, panels, and boxes directly to beams or columns. Mount struts to beams or columns using beam clamps, and mount equipment, enclosures, panels, and boxes to the struts.
3. Floor Stand Rack:
 - a. Where equipment, cabinets, consoles, panels, enclosures, and boxes cannot be wall-mounted, provide an independent floor stand rack.
 - b. Floor stand rack shall consist of struts, plates, brackets, connection fittings, braces, accessories, and hardware assembled in a rigid framework suitable for mounting of intended materials and equipment.
 - c. Equip floor stand racks with brackets and bases for rigidly-mounting the framework to the ceiling or floor, as applicable; or equip floor stand racks with beam clamps, angle plates, washers, and bolts for fastening to beam flanges, as applicable.
 - d. When equipment, cabinets, consoles, panels, enclosures, and boxes weigh more than 100 pounds:
 - 1) Main vertical supports of floor stand rack assemblies shall be back-to-back struts.
 - 2) Bracing, clamping and anchoring of each floor stand rack shall be sufficient to ensure rigidity of the floor stand rack with the intended equipment, enclosures, conduit, cable tray, busway, cablebus, and wireway installed. Floor stand racks shall not be deflected more than 1/8-inch by a 100-pound force applied at any point on the floor stand rack in any direction.

H. Drilling into beams or columns is not allowed unless authorized by OWNER.

I. Tighten nuts and bolts to the manufacturer's recommended torque values.

J. Field Cutting:

1. Cut edges of strut and hanger rod shall have rounded corners, edges beveled, and burrs removed. If field cutting the strut is required, use clean, sharp, dedicated tools. Remove oil, shavings, and other residue of cuttings prior to installation.
2. Coatings: To prevent corrosion:
 - a. Coat cut edges with epoxy-base touchup paint.

+ + END OF SECTION + +

SECTION 26 05 33.13

RIGID CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated and grounded raceway systems.
2. When specific, detailed conduit routings for various systems within buildings and other areas are not shown on the Drawings, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.
3. Conduit types and the installation methods shall comply with the following, unless otherwise shown or indicated in the Contract Documents:
 - a. Use steel conduit (rigid steel or intermediate metallic) for exposed indoor conduit runs in non-corrosive areas.
 - b. Use PVC-coated rigid steel or aluminum conduit for exposed interior or exterior conduit runs in hazardous, wet, and corrosive locations.
 - c. Use PVC-coated rigid steel conduit for individual conduits direct-buried in the ground.

B. Coordination:

1. For conduits to be embedded in concrete slabs, confirm adequate slab thickness and coordinate location of conduits with placement of reinforcing steel, waterstops, expansion joints, and other features of the concrete slab.

C. Related Sections:

1. Section 26 05 29, Hangers and Supports for Electrical Systems.
2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI C80.1, Standard for Rigid Electrical Steel Conduit (ERSC).
2. ANSI/NEMA FB1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
3. UL 6, Electrical Rigid Metal Conduit – Steel.
4. UL 514B, Conduit, Tubing, and Cable Fittings.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 344, Rigid Metal Conduit.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.
- B. Closeout Submittals: Submit the following:
 - 1. Record Drawings:
 - a. Show actual routing of exposed and concealed conduit runs in record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Rigid Steel Conduit, Elbows, and Couplings:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Allied Tube and Conduit.
 - b. Wheatland Tube Company.
 - c. Western Tube and Conduit Corporation.
 - d. Or equal.
 - 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
- B. PVC-coated Rigid Steel Conduit, Elbows, and Couplings:
 - 1. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Perma-Cote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 - 2. Material: Rigid, heavy-wall, mild steel, hot-dip galvanized, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
 - 3. Color: Color of coating shall be the same on all conduit and fittings.
- C. Conduit Bushings and Locknuts:
 - 1. Manufacturers: Provide products one of the following:
 - a. O-Z/Gedney.
 - b. Appleton Electric Company.
 - c. Or equal.
 - 2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
 - 3. Locknuts: Steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
 - 4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.

D. Thru-wall Seals

1. For new construction through exterior subsurface walls and exterior concrete walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type WSK and WSCS by O-Z/Gedney.
 - 2) Or equal.
2. For new construction passing through concrete floors and floor slabs.
 - a. Manufacturer: Provide one of the following:
 - 1) Type FSK and FSCS floor seals by O-Z/Gedney.
 - 2) Or equal.
3. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.
 - a. Manufacturer: Provide one of the following:
 - 1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
 - 2) Or equal.

2.2 ACCESSORIES

- A. Fasteners: To the extent possible, fastener material shall be consistent with conduit material. For PVC-coated rigid steel conduit runs, fasteners shall have factory applied PVC coating or be stainless steel. Fasten raceway systems to supporting structures using the following:
1. To Wood: Wood screws.
 2. To Hollow Masonry Units: Toggle bolts, in accordance with Section 05 05 33, Anchor Systems.
 3. To Brick Masonry: Expansion bolts by Price, or equal.
 4. To Concrete: Anchors in accordance with Section 05 05 33, Anchor Systems.
 5. To Steel: Beam clamps in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.

2.3 IDENTIFICATION

- A. Conduit Labels:
1. Provide conduit labels in accordance with Section 26 05 53, Identification for Electrical Systems.
- B. Warning Tape:
1. Provide warning tape in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install in accordance with Laws and Regulations.
- B. Supports:
 - 1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
 - 2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.
- C. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.
- D. Exposed Conduit:
 - 1. Install parallel or perpendicular to structural members or walls.
 - 2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
 - 3. Install on structural members in protected locations.
 - 4. Locate clear of interferences.
 - 5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
 - 6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.
- E. Conduit Embedded in Structural Concrete:
 - 1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
 - 2. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:
 - a. Minimum concrete thickness shall be as follows:
 - 1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
 - 2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
 - 3) For concrete at foundation slabs, provide an one inch additional to minimum concrete thicknesses specified.

- b. Conduit spacing shall be as follows:
 - 1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
 - 2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
 - 3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit.
- F. Underground Conduits:
 - 1. Install individual, underground conduits minimum of 18 inches below grade, unless otherwise shown or indicated.
 - 2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Section 32 12 00, Flexible Paving.
 - 3. Install warning tape 12 inches below finished grade over buried conduits.
- G. Empty Conduits:
 - 1. Install nylon pull wire in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose.
- H. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.
- H. Joints:
 - 1. Apply conductive compound to joints before assembly.
 - 2. Make up joints tight and ground thoroughly.
 - 3. Use standard tapered pipe threads for conduit and fittings.
 - 4. Cut conduit ends square and ream to prevent damaging wire and cable.
 - 5. Use full threaded couplings. Split couplings are not allowed.
 - 6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.
 - 7. Apply zinc-rich paint to exposed threads and other areas of galvanized conduit system where base metal is exposed.
- I. Terminations:
 - 1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
 - 2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.
 - 3. Use of bushings in lieu of locknuts is not allowed.
 - 4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.

J. Moisture Protection:

1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
2. Underground and embedded conduit connections shall be watertight.
3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.

K. Corrosion Protection:

1. Dissimilar Metals:
 - a. Prevent occurrence of electrolytic action between dissimilar metals.
 - b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
 - c. Back paint aluminum in contact with masonry or concrete with two coats of aluminum-pigmented bituminous paint.

L. Reused Existing Conduits:

1. Pull rag swab through conduits to remove water and to clean conduit prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.
3. Pull mandrel through conduit, if necessary, to remove obstructions.

M. PVC-coated Rigid Steel Conduit:

1. Install in accordance with manufacturer's recommendations.
2. Install with manufacturer's installation tools to avoid damage to PVC coating.
3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.

N. Identify conduits, including spares, in accordance with Section 26 05 53, Identification for Electrical Systems.

3.3 FIELD QUALITY CONTROL

A. Site Tests:

1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduit's inside diameter.
2. Repair or replace conduits that do not successfully pass testing, and re-test.

++ END OF SECTION ++

SECTION 26 05 33.16

FLEXIBLE CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 360, Liquid-Tight Flexible Steel Conduit.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 350, Liquid-Tight Flexible Metal Conduit.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data: Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Flexible Conduit (Non-hazardous Areas and Class 1, Division 2, Hazardous Areas):
 - 1. Material: Flexible galvanized steel core with smooth, abrasion-resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 1.25-inch. Material shall be UL-listed.
 - 2. Products and Manufacturers: Provide one of the following:
 - a. Anaconda Sealtite Type UA by Anamet Electrical, Inc.
 - b. Liqueflex Type L.A. by Electric-Flex Company.
 - c. Or equal.
- B. Flexible Conduit Fittings:
 - 1. Material and Construction: Malleable iron with cadmium finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.

2. Manufacturers: Provide products of one of the following:
 - a. Crouse-Hinds Company.
 - b. Appleton Electric Company.
 - c. Or equal.
 3. Use: Provide on flexible conduit in non-hazardous and Class 1, Division 2 hazardous areas.
- C. PVC-Coated Conduit Fittings:
1. Material and Construction: Malleable iron with standard finish and 40-mil PVC exterior coating. Fittings shall adapt the conduit to standard threaded connections and shall have an inside diameter not less than that of the corresponding standard conduit size.
 2. Manufacturers: Provide products of one of the following:
 - a. Robroy Industries.
 - b. Permacote Industries.
 - c. OCAL, Inc.
 - d. Or equal.
 3. Use: Provide on flexible conduit in areas designated as corrosive locations.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.
- B. Install in conformance with the Laws and Regulations.

+ + END OF SECTION + +

SECTION 26 05 33.23

SEALED FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit sealing fittings with sealing fiber and sealing compound.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations, Class I, Groups A, B, C and D and Class II, Groups E, F and G.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 500, Hazardous (Classified) Locations.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Listing of locations where fittings are to be used.
 - 2. Product Data:
 - a. Manufacturer's literature and technical information for sealing fittings, sealing fiber, and sealing compound proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers: Provide products of one of the following:
 - 1. Crouse Hinds Company.
 - 2. Appleton Electric Company.
 - 3. Or equal.
- B. Materials and Construction:
 - 1. Cast gray iron alloy, or cast malleable iron, or copper free aluminum bodies with zinc electroplate and lacquer or enamel finish.
 - 2. Ample opening with threaded closure for access to conduit hub for making dam.

- 3. In corrosive locations, fittings shall include factory-applied 40-mil PVC coating.
- 4. Construct fitting to allow 40 percent cross-sectional fill.
- C. Sealing fiber for forming the dam within the hub and sealing compound shall be suitable for use with fittings furnished and shall be products of fitting manufacturer.
- D. Sealing fitting, fiber, and sealing compound shall conform to UL 886.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install for hazardous locations as required by Laws and Regulations and as shown.
- B. Provide fittings for proper use relative to mounting position.
- C. Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

+ + END OF SECTION + +

SECTION 26 05 33.26

EXPANSION/DEFLECTION FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install conduit expansion and deflection fittings.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 514B, Conduit, Tubing, and Cable Fittings.
 - 2. UL 467, Grounding and Bonding Equipment.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with the following:
 - 1. NEC Article 300, Wiring Methods.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's literature and technical information for expansion and deflection fittings proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Products and Manufacturers: Provide one of the following:
 - 1. Type DX for expansion/deflection or AX for expansion only, by O-Z Gedney Company.
 - 2. Type XD for expansion/deflection or XJ for expansion only, by Crouse Hinds Company.
 - 3. Type DF for expansion/deflection or XJ for expansion only, by Appleton Electric Company.
 - 4. Or equal.

- B. Cast gray iron alloy or bronze end couplings, malleable iron, or hot-dipped galvanized body, stainless steel clamps and tinned copper braid bonding jumper. Fitting shall be watertight, corrosion-resistant, UL-listed, and compatible with the conduit system.
- C. Features:
 - 1. Expansion/Deflection Fittings:
 - a. Axial expansion or contraction up to 3/4-inch.
 - b. Angular misalignment up to 30 degrees.
 - c. Parallel misalignment up to 3/4-inch.
 - 2. Expansion Fittings:
 - a. Expansion/Contraction: Eight-inch total movement.
- D. Expansion/Deflection fittings shall comply with UL 514B and UL 467.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install fittings in accordance with Laws and Regulations.
- B. Provide expansion fittings on exposed conduit runs crossing structural expansion joints and where necessary to compensate for thermal expansion and contraction. Provide expansion fittings on exposed conduit runs exceeding 200 feet.
- C. Provide expansion/deflection fittings on embedded conduit runs crossing structural expansion joints. Provide fittings above waterstops.
- D. Unless specifically shown or indicated otherwise, when crossing structural expansion joints larger than one inch, provide expansion fitting together with expansion/ deflection fitting. Install fittings on each conduit run in accordance with manufacturer's recommendations to accommodate additional movement necessary.
- E. Provide expansion/deflection fittings for underground conduit runs at penetrations of buildings, manholes, handholes, and outdoor concrete equipment pads.
- F. Where required in non-metallic conduit and duct systems, provide rigid metal conduit nipples and metal rigid-to-PVC adapters for connection to fittings. Ensure that joints exposed to water or other liquid are made watertight.

++ END OF SECTION ++

SECTION 26 05 33.33

PULL, JUNCTION, AND TERMINAL BOXES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 29, Hangers and Supports for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are.
 - 1. UL 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC Article 314, Outlet, Device, Pull and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's technical information for pull, junction, and terminal boxes proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pull, Junction, and Terminal Boxes:

1. General – Applicable to All Boxes:
 - a. Description and Performance Criteria:
 - 1) Provide pull, junction, and terminal boxes rated at not less than NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
 - 2) For flush-mounted pullboxes in slabs or pavement potentially subject to vehicular traffic, boxes and covers shall be constructed for H-20 loading in accordance with AASHTO Standard Specifications for Highway Bridges.
 - b. Manufacturers: Provide products of one of the following:
 - 1) Appleton Electric Company.
 - 2) Crouse-Hinds Company.
 - 3) Hoffman Engineering Company.
 - 4) Or equal.
 - c. Materials: Pull boxes embedded in concrete slabs shall be cast iron.
 - d. Terminal strips and terminal blocks in terminal boxes shall be mounted on terminal box sub-panels.
 - e. Identification: Boxes shall be identified in accordance with Section 26 05 53, Identification for Electrical Systems.
2. Materials and Construction – Dusty Locations:
 - a. Material: Welded and galvanized sheet steel of USS gage.
 - b. Gasket: Oil-resistant gasket.
 - c. Access: Lift-off hinges and quick-release latches.
 - d. Material Thickness:
 - 1) Boxes with dimension two feet and smaller shall be 14-gauge.
 - 2) Boxes with dimension between two and three feet shall be 12 gauge.
 - 3) Boxes with dimension of three feet or more in any direction shall be 10-gage.
3. Materials and Construction - Wet, Corrosive, or Hazardous Locations:
 - a. Rating:
 - 1) Pull boxes in wet, corrosive, or outdoor areas shall be NEMA 4X.
 - 2) Boxes for areas classified as hazardous locations, where required by NEC, shall be explosion-proof and comply with UL 886.
 - b. Material:
 - 1) Cast gray iron alloy with hot-dip galvanized finish or cast malleable iron bodies and covers.
 - 2) Large boxes not generally available in cast iron construction shall be copper-free aluminum alloy or Type 316 stainless steel, as required by location.

- 3) In corrosive locations, where the conduit system is PVC-coated, boxes shall be cast metal with factory-applied 40-mil PVC coating, Type 316 stainless steel, or non-metallic thermoplastic or fiberglass reinforced plastic material.
 - c. Gasket:
 - 1) Provide neoprene gaskets for wet and corrosive locations.
 - 2) Gaskets shall be an approved type designed for the purpose. Improvised gaskets are not acceptable.
 - d. Access: Stainless steel cover bolts.
 - e. Features:
 - 1) External mounting lugs.
 - 2) Drilled and tapped conduit holes.
 - 3) Boxes where conduits enter building or structure below grade shall have 1/4-inch drain hole at bottom of the box.
 - 4) Provide threaded connections for explosion proof boxes.
- B. Terminal Blocks:
- 1. Products and Manufacturers: Provide one of the following:
 - a. Allen-Bradley Company, Bulletin, Model 1492.
 - b. General Electric Company, Model CR151K.
 - c. Or equal.
 - 2. Material and Construction:
 - a. NEMA-rated nylon modular terminal blocks.
 - b. 600-volt rated.
 - c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
 - d. Power terminals shall be copper and rated for the circuit ampacity.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.
- B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.

- C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:
 - 1. Conduit runs containing more than three 90-degree bends.
 - 2. Conduit runs exceeding 200 feet in length.
- D. Provide removable, flame-retardant, insulating cable supports in boxes with any dimension exceeding three feet.
- E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.
- F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.
- G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

+ + END OF SECTION + +

SECTION 26 05 43.13

UNDERGROUND DUCTBANKS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install underground ductbanks.
- B. Coordination:
 - 1. Coordinate installation with piping and other Underground Facilities and locate ductbanks clear of interferences.
 - 2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground ductbank Work.
- C. Related Sections:
 - 1. Section 26 05 26, Grounding and Bonding for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.
 - 3. Section 26 05 33.13, Rigid Conduits.
 - 4. Section 26 05 33.26, Expansion/Deflection Fittings.

1.2 SUBMITTALS

- A. Closeout Submittals: Submit the following:
 - 1. Record Drawings:
 - a. Include actual routing of underground ductbank runs on record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Duct: Provide conduit and fittings in accordance with Section 26 05 33.13, Rigid Conduits. Conduit types shall be as follows:
 - 1. Galvanized rigid steel conduits for the following types of circuits: low voltage status, analog, and communication.
- B. Backfill: Provide backfill, including select backfill, in accordance with Section 31 23 05, Excavation and Fill.

- C. Concrete: Provide ductbank concrete in accordance with Section 03 00 05, Concrete.
- D. Grounding: Provide ground cable in accordance with Section 26 05 26, Grounding and Bonding for Electrical Systems.
- E. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Excavation and Backfilling:
 - 1. Provide excavation and backfilling for ductbank installation in accordance with Section 31 23 05, Excavation and Fill.
 - 2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can damage or contribute to corrosion of ducts or cables or prevent adequate compaction of backfill.
- B. Conduit Transitions:
 - 1. Conduit installations shall be watertight throughout entire length of ductbank.
 - 2. Terminate conduits in insulated grounding bushings.
 - 3. Continue conduits inside buildings in accordance with Section 26 05 33.13, Rigid Conduits, and as shown or indicated in the Contract Documents.
 - 4. If ducts are not concrete-encased, provide expansion and deflection fittings in accordance with Section 26 05 33.26, Expansion/Deflection Fittings.
 - 5. Plug and seal empty spare conduits entering structures. Conduits in use entering structures shall be sealed watertight with duct sealing compound.
- C. Detectable Underground Warning Tape:
 - 1. Provide detectable underground warning tapes complying with Section 26 05 53, Identification for Electrical Systems, over the full length of each underground ductbank.
 - 2. Install warning tapes approximately 12 inches below grade.

D. Reused Existing Ducts:

1. Pull rag swab through duct to remove water and to clean conduits prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.
3. Pull mandrel through duct, if necessary, to remove obstructions.

+ + END OF SECTION + +

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

B. Related Sections:

1. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:

1. NEC Article 110, Requirements for Electrical Installation.
2. NEC Article 210, Branch Circuits.
3. NEC Article 215, Feeders.
4. NEC Article 702, Optional Standby Systems.
5. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
6. NFPA 70E, Electrical Safety in the Workplace.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):

1. Nameplates:
 - a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
 - b. Size: As required.
 - c. Letter Size: Minimum 3/16-inch.
 - d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.

B. Safety Signs and Voltage Markers:

1. Low-Voltage Safety Signs:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-302-86060 by Brady.
 - 2) Or equal.
 - b. Low voltage safety signs shall be pressure-sensitive vinyl complying with 40 CFR 1910.145, five inches by 3.5 inches in size, and shall read, "DANGER – 480 VOLTS".
2. Low-Voltage Markers:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) CV442xx by Brady.
 - 2) Or equal.
 - b. Low voltage markers shall be either pressure-sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, "120 VOLTS", "208 VOLTS", "120/208 VOLTS", or "240 VOLTS" as required.

C. Arc-flash Safety Signs:

1. Products and Manufacturers: Provide one of the following:
 - a. Brady.
 - b. Or equal.
2. Warning signs shall be adhesive-backed polyester.
3. Warning signs shall read, "Warning – Arc Flash and Shock Hazard. Appropriate PPE Required. Arc flash warning signs shall indicate the flash protection boundary, incident energy in calories per square centimeter, hazard level, description of required protective clothing, shock hazard, limited approach boundary, restricted approach boundary, prohibited approach boundary, and equipment name.

D. Voltage System Identification Directories:

1. General:
 - a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
 - b. Directories shall identify all voltage systems within building or structure.
 - c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
 - d. Colors shall be in accordance with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
 - e. Example Directory Text:

Voltage System Identification		
System	A, B, C	Neutral
277/480	Brown, Orange, Yellow	Gray
120/208	Black, Blue, Red	White

2. Large directories for rooms shall have text height not less than 1/2-inch.
 3. Small directories for equipment shall have text height of not less than 1/4-inch.
- E. Wire Identification:
1. Heat Shrinkable Wire and Cable Labeling System:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) B-341 PS-xxx-2W by Brady.
 - 2) Or equal.
 - b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
 2. Wrap-Around Wire and Cable Labeling System:
 - a. Products and Manufacturers: Provide one of the following:
 - 1) THT-XX-427 by Brady.
 - 2) Or equal.
 - b. Self-laminating white/transparent self-extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.
- F. Detectable Underground Warning Tape:
1. Products and Manufacturers: Provide one of the following:
 - a. Indentoline by Brady.
 - b. Or equal.
 2. Material: Polyethylene or polyester with detectable metal core and polyester underlamine.
 3. Width: Two inches.
 4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.
- G. Thermal Printing System:
1. Utilize thermal transfer process to provide non-smearing labels and markers.
 2. Wire and Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) TLS2200 by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) 200M by Brady.
 - 2) Or equal.
 3. Cable Markers:
 - a. Portable, Products and Manufacturers: Provide one of the following:
 - 1) Handimark by Brady.
 - 2) Or equal.
 - b. Desktop, Products and Manufacturers: Provide one of the following:
 - 1) Labelizer PLUS by Brady.
 - 2) Or equal.

H. Generator System Warning Signs:

1. Generator warning signs shall be labeled in accordance with NEC Article 700, NEC Article 701, or NEC Article 702.
2. Material, Colors, Letters: Plastic with white letters on red background. Letters shall be not less than 3/8-inch high.
3. Attachment: Use stainless steel self-tapping screws.
4. Location warning sign shall read, "WARNING – THIS SITE EQUIPPED WITH A DIESEL DRIVEN STAND-BY GENERATOR LOCATED IN AN ADJACENT ROOM".
5. Generator ground warning sign shall read, "WARNING – GENERATOR GROUNDED CIRCUIT CONDUCTOR IS CONNECTED TO THE GROUNDING ELECTRODE CONDUCTOR IN THIS ENCLOSURE. DO NOT OPERATE GENERATOR WHILE EITHER CONDUCTOR IS DISCONNECTED TO AVOID SEVERE SHOCK HAZARD AND POSSIBLE EQUIPMENT DAMAGE."

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment and materials.
- B. Engraved Identification Devices (Nameplates and Legend Plates):
 1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.
 2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
 3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
 4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
 5. Except conduit, all electrical appurtenances including lighting panels, convenience outlets, fixtures, and lighting switches, shall be provided with nameplates indicating appropriate circuit breaker number(s).
 6. Push Buttons:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
 - c. Provide red buttons for stop function.
 - d. Provide black buttons for other functions.

- e. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	Legend
Green	Running, Open
Red	Stopped, Closed
Amber	Alarm
Blue	Power
White	Status

7. Selector Switches:
 - a. Provide legend plates for identification of functions.
 - b. Provide nameplates for identification of controlled equipment.
8. Panel Mounted Instruments:
 - a. Provide nameplates for identification of function.
9. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
 - a. Provide nameplates for identification.
 - b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved Shop Drawings and CONTRACTOR's other submittals. Install nameplates with adhesive.
 - c. Circuit Breaker Directory:
 - 1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.
10. Re-label existing equipment whose designation have changed.

C. Voltage System Identification Directories

1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
2. For panelboards, switchboards, motor control centers, and other branch circuit or feeder distribution equipment that are not located in electrical rooms, provide voltage system identification directory mounted on equipment.
 - a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
 - b. Directories shall be readily visible and not obscure labels and other markings on equipment.

D. Arc-flash Safety Signs:

1. Provide arc-flash safety signs as required by NEC Article 110.
2. Provide signs for switchboards, panelboards, motor control centers, and industrial control panels. Provide signs for control panels that contain 480 volt equipment. Provide arc flash warning signs on other equipment where the incident energy is greater than 1.2 calories per square centimeter.

- E. Wire and Cable Identification:
1. Color-coding of insulated conductors shall comply with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
 2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
 3. Do not provide labels for the following:
 - a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
 4. Provide wire and cable labels for the following:
 - a. New, rerouted, or revised wire or cable.
 - b. Insulated conductors.
 - c. Wire and cable terminations:
 - 1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
 - 2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
 - a) Label individual conductors in a cable after breakout as specified for wires.
 - d. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
 - 1) Label wires or cables within two inches of entrance to conduit.
 - e. Wire or cable in junction boxes and pull boxes
 - 1) Label wires or cables within two inches of entrance to conduit.
 5. Wire and Cable Identification System:
 - a. Wire and cable labels shall be imprinted with an identifying designator.
 - 1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.
 - b. Field Wiring:
 - 1) Wire or cable designator shall consist of:
 - a) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.
 - b) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.
 - c) Remaining characters shall be alphanumeric and make wire designator unique.
 - d) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.
 6. Modified Cabinets, Consoles, Panels, and Enclosures:
 - a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.

F. Generator System Warning Signs:

1. Provide warning signs for generator systems as required by NEC.
2. Install generator location warning sign on or immediately adjacent to service equipment, or to “normal” source disconnecting means when generator is located out of sight of service equipment or disconnecting means.
3. Install generator grounding warning sign on enclosure or immediately adjacent to point where generator neutral is connected to grounding electrode system if connection is made remote from generator.

+ + END OF SECTION + +

SECTION 26 28 16.33

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.
- B. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. UL 98, Enclosed and Dead-Front Switches.
 - 2. NEMA KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 3. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. NEC Article 404, Switches.
 - 2. Disconnect switches shall bear the UL label.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's technical information for disconnect switches proposed for use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. Square-D Company.
 - 2. Cutler-Hammer.
 - 3. General Electric Company.
 - 4. Siemens.
 - 5. Or equal.

2.2 MATERIALS

- A. Service Disconnect Switches:
 - 1. Type: Enclosed circuit breaker, heavy-duty, single throw, quick-make, quick-break mechanism, visible blades in "OFF" position and safety handle.
 - 2. Rating: Voltage, current and short circuit ratings and number of poles as shown or indicated on the Drawings. Switch shall bear UL label indicating suitability for use as service equipment and shall comply with UL 98, NEMA KS 1, and NEMA 250.
 - 3. Provide auxiliary dry contacts to indicate switch position where shown on the Drawings.
 - 4. Provide auxiliary dry contacts to indicate switch position.
- B. Enclosures: NEMA rating shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
- C. Identification:
 - 1. Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems.
 - 2. Provide nameplate to identify the equipment served by disconnect switch and associated source of power.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.
- B. Securely fasten equipment to walls or other structural supports on which they are mounted. Provide independent stainless steel supports where no wall or other structural surface exists. Mount disconnect enclosures at a height not exceeding six feet.
- C. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

++ END OF SECTION ++

SECTION 26 28 17

ENCLOSED CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish and install molded-case thermal magnetic circuit breakers each in NEMA-rated enclosure with size and trip rating as shown or specified.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before enclosed circuit breakers Work.
- C. Related Sections:
 - 1. Section 26 05 05, General Provisions for Electrical Systems.
 - 2. Section 26 05 29, Hangers and Supports for Electrical Systems.
 - 3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. NFPA 70, National Electrical Code.
 - 2. NEMA AB 1, Molded-case Circuit Breakers
 - 3. UL 50, Enclosures for Electrical Equipment
 - 4. UL 50E, Enclosures for Electrical Equipment, Environmental Considerations
 - 5. UL 489, Molded-case Circuit Breakers

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer:
 - a. Manufacturer shall have not less than five years of experience producing substantially similar equipment to that required and, upon request, shall submit documentation of not less than five installations in satisfactory operation for not less than five years in the United States.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's technical information for enclosed circuit breakers proposed for use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer: Provide equipment by one of the following:
 - 1. Eaton Cutler Hammer
 - 2. General Electric
 - 3. Square-D
 - 4. Or equal

2.2 MATERIAL AND FABRICATION

- A. Type:
 - 1. Breakers shall be molded case with inverse time and instantaneous tripping characteristics.
 - 2. Circuit breakers shall be operated by toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically trip-free. Automatic tripping of circuit breaker shall be clearly indicated by the handle position. Contacts shall be non-welding silver alloy with arc-extinction chutes. Push-to-trip button shall provide local manual means to exercise the trip mechanism.
 - 3. For frame sizes 150-ampere and below, provide with non-interchangeable trip.
 - 4. Terminations: Provide terminals for accommodating two normal-range copper cables per phase.
 - 5. Enclosed circuit breakers shall be UL-listed and bear the UL label, and shall comply with UL 489 and NEMA AB 1.
- B. Interrupting Capacities:
 - 1. Ampere Frame size as shown on the drawings: Minimum 22,000 amperes RMS symmetrical at 480-volt, three-phase, 60 Hertz, or as shown.
- C. Enclosure:
 - 1. NEMA type as required in Section 26 05 05 General Provisions for Electrical Systems.
 - 2. Access Door Interlock: Provide disconnect device to prevent unintentional opening of door while circuit breaker is energized and unintentional application of load power while door is open, with provisions for releasing interlock for intentional access or application of power by authorized personnel.
 - 3. External operating handle shall be integral part of the associated box, not the door. Operating handle shall have provisions for padlocking in the "OFF" position with door open or closed and shall include prominent trip indication.
 - 4. Identification: Provide nameplate identification of circuit breaker in accordance with Section 26 05 53, Identification for Electrical Systems. Identify load side equipment controlled and line side source.
 - 5. Enclosures shall be UL-listed and comply with UL 50 and UL 50E.

2.3 SOURCE QUALITY CONTROL

- A. Tests:
 - 1. Perform standard factory tests on equipment furnished under this Section.
Tests shall be in accordance with applicable NEMA and UL standards.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install in accordance with NFPA 70, and Laws and Regulations.
- B. Mounting and Installation:
 - 1. Install equipment to provide sufficient access and working space for ready and safe operation and maintenance. Equipment centerline shall not be less than four feet above finished floor.
 - 2. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports complying with Section 26 05 29 Hangers and Supports for Electrical Systems, where there is no wall or other surface capable of supporting the equipment.
 - 3. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

3.3 FIELD QUALITY CONTROL

- A. Field Tests and Inspections:
 - 1. All test equipment and material shall be by CONTRACTOR.
 - 2. Perform visual and mechanical inspection including:
 - a. Inspect for physical, electrical, and mechanical condition.
 - b. Check for proper installation, required area clearances, physical damage, and proper alignment.
 - c. Check electrical and mechanical interlock systems for proper operation.
 - d. Clean and lubricate as required.
 - e. Other testing and inspections recommended by manufacturer.

++ END OF SECTION ++

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform clearing and grubbing as shown and specified in the Contract Documents.
2. The Work includes removing from the Site and disposing of trees, stumps, brush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material.
3. Pay all costs associated with transporting and disposing of debris resulting from clearing.
4. Limits of Clearing and Grubbing Work: Clear and grub all areas within the Work areas unless otherwise shown or indicated in the Contract Documents.

B. Related Sections:

1. Section 01 57 05, Temporary Controls.
2. Section 02 41 00, Demolition.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with Laws and Regulations for environmental requirements, disposal of debris, and use of herbicides.

1.3 SUBMITTALS

A. Action Submittals: Submit the following

1. Shop Drawings:
 - a. Plan for removing trees and other large vegetation not explicitly shown or indicated for removal in the Contract Documents.
 - b. Plan showing proposed limits of clearing and grubbing, if different from clearing and grubbing limits shown or indicated in the Contract Documents.

1.4 WARRANTY

- ###### A.
- CONTRACTOR shall warrant that Work performed under this Section will not permanently damage trees, shrubs, turf, and plants designated to remain, or other adjacent work, facilities, or property. If damage resulting from CONTRACTOR's operations becomes evident during the correction period, CONTRACTOR shall replace damaged items and property at no additional cost to OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection:

1. Throughout the Project, protect existing site improvements, including streets, drives, and Underground Facilities to remain (if any), and adjacent property and structures. Repair damage caused by CONTRACTOR to original condition or replace in kind, to satisfaction of ENGINEER, at no additional cost to OWNER.
2. Protect trees, shrubs, vegetation, and grassed areas to remain by providing temporary fencing, barricades, wrapping, or other methods shown, specified, or accepted by ENGINEER. Correct at CONTRACTOR's expense damage caused by CONTRACTOR outside the limits of clearing Work.
3. Do not remove trees without approval of ENGINEER, unless shown or indicated for removal.
4. Do not locate construction equipment, stored materials, or stockpiles within drip line of trees and vegetation to remain.

B. Site Preparation:

1. Obtain, pay costs associated with, and comply with applicable permits required for clearing and grubbing Work.
2. Delineation of Clearing and Grubbing Limits:
 - a. Locate and clearly flag trees and vegetation to remain, and other materials to remain in the clearing and grubbing limits. Locate and clearly flag salvable vegetation to be relocated.
 - b. Provide flagging to delineate limits of areas to be cleared or grubbed. Review at Site with ENGINEER before commencing removal of trees, vegetation, and other materials to be removed.
 - c. Replace flagging that is lost, removed, or destroyed, until clearing and grubbing Work is complete and ENGINEER allows removal of flagging.
3. Erosion and Sediment Controls:
 - a. Provide applicable erosion and sediment controls before commencing clearing and grubbing Work.
 - b. Comply with erosion and sediment control requirements of Section 01 57 05, Temporary Controls.
 - c. Continue providing erosion and sediment controls as clearing and grubbing Work progresses to previously uncleared, ungrubbed areas of the Site.

3.2 CLEARING AND GRUBBING

- #### A.
- Remove and dispose of all trees, shrubs, stumps, roots, brush, logs, rubbish, and debris within limits of clearing and grubbing shown or indicated in the Contract Documents, unless otherwise shown or indicated.

- B. Trees and Shrubs Improperly Destroyed or Damaged:
 - 1. For each tree or shrub to remain that is destroyed or damaged beyond repair by CONTRACTOR, provide two replacements of the same species at locations to be designated by ENGINEER.
- C. Trees and shrubs to remain that have been damaged or require trimming shall be treated and repaired under the direction of a qualified arborist, or other professional with qualifications acceptable to ENGINEER. Trees and shrubs intended to remain, that are damaged beyond repair or that are removed, shall be replaced by CONTRACTOR at no additional cost to OWNER.
- D. Disposal of Cleared and Grubbed Materials:
 - 1. Dispose at appropriate off-Site location trees, stumps, rubbish, debris, and other cleared and grubbed material. Cleared or grubbed materials may remain at the Site only when allowed in the Contract Documents or when approved by ENGINEER in writing. Do not use cleared or grubbed material as fill, backfill, or in embankments.
 - 2. Dispose of cleared and grubbed material in accordance with Laws and Regulations.
 - 3. Do not burn clearing debris at the Site, unless approved by OWNER and authorities having jurisdiction. If burning is permitted, comply with requirements of authorities having jurisdiction and Laws and Regulations. If burning is permitted at the Site, also comply with OWNER's requirements.
- E. Removal of Site Improvements: Comply with Section 02 41 00, Demolition.

3.3 TOPSOIL REMOVAL

- A. Existing topsoil to be removed is defined as friable, clay loam, surface soil present in depth of at least four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material.
- B. Stripping:
 - 1. Strip topsoil to depths encountered, in manner that prevents intermingling of topsoil with underlying subsoil or other objectionable material. Remove heavy growths of grass and vegetation from areas before stripping.
- C. Stockpile topsoil in storage stockpiles in areas shown, or where otherwise accepted by ENGINEER. Construct storage piles so that surface water drains freely. Stabilize large topsoil piles with a cover crop and mulch, and provide silt fencing around perimeter of pile to prevent topsoil erosion and sedimentation; silt fencing shall be in accordance with Section 01 57 05, Temporary Controls. Cover smaller topsoil stockpiles, when used, with reinforced fabric to prevent windblown dust.

+ + END OF SECTION + +

SECTION 31 23 05

EXCAVATION AND FILL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of structures, Underground Facilities, roads, and other facilities required to complete the Work.
2. Preparation of subgrade for slabs and pavements is included under this Section.
3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

B. Related Sections:

1. Section 03 00 05, Concrete.

C. Standards referenced in this Section are:

1. ANSI/AISC 360, Specification for Structural Steel for Buildings.
2. ASTM D422, Test Method for Particle-Size Analysis of Soils.
3. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
4. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
5. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
6. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
7. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
8. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
9. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
10. ASTM D4832, Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
11. ASTM D6023, Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
12. ASTM D6103, Test Method for Flow Consistency of Controlled Low Strength Material (CLSM).

13. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
14. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.2 TERMINOLOGY

- A. The following words or terms are not defined but, when used in this Section, have the following meaning:
 1. “Subgrade” is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.

1.3 ADDITIONAL WORK ITEMS

- A. Item A.5 – Additional Excavation: Provide under the provisions of Section 01 22 13, Measurement and Payment.
- B. Item A.6 – Additional “Select Fill”: Provide under the provisions of Section 01 22 13, Measurement and Payment.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 1. Professional Engineer:
 - a. Engage a registered professional engineer legally qualified to practice in the same jurisdiction as the Site and experienced in providing engineering services of the kind indicated.
 - b. Responsibilities include but are not necessarily limited to:
 - 1) Reviewing system performance and requirements shown or indicated in the Contract Documents.
 - 2) Preparing written requests for clarifications or interpretations of performance and requirements for submittal to ENGINEER by CONTRACTOR.
 - 3) Preparing or supervising the preparation of design calculations and related submittals verifying compliance of the system with the requirements of the Contract Documents.
 - 4) Signing and sealing all calculations, drawings, and submittals prepared by professional engineer.
 - 5) Certifying that:
 - a) it has performed the design of the system in accordance with the performance requirements stated in the Contract Documents, and
 - b) the said design conforms to Laws and Regulations, and to the prevailing standards of practice.

2. CONTRACTOR's Testing Laboratory:
 - a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials specified in this Section.
 - b. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
 - c. Testing laboratory shall be experienced in the types of testing required.
 - d. Selection of testing laboratory is subject to ENGINEER's acceptance.
- B. Quality Assurance Testing:
 1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.
 2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
 3. CONTRACTOR's Testing Laboratory Scope:
 - a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work with the Contract Documents.
 - b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
 - c. Design controlled low-strength material (CLSM) mixes in accordance with requirements of CLSM Article in Part 2 of this Section. Perform concrete materials evaluation tests and testing of CLSM mixes.
 - d. Submit to ENGINEER and CONTRACTOR written report results of each test.
 4. Required Quality Assurance Material Testing by CONTRACTOR's Testing Laboratory:
 - a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
 - b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
 - c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 5,000 cubic yards of the following types of materials incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.
 - d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of the following types of material incorporated into the Work: select fill, general fill, subbase material, drainage fill, and pipe bedding material.

- e. CLSM Mix: Verify CLSM mix design by laboratory trial batch, unless indicated otherwise. Perform the following testing on each concrete mix trial batch:
 - 1) Aggregate gradation.
 - 2) Flowability, in accordance with ASTM D6103.
 - 3) Air content, in accordance with ASTM D6023.
 - 4) Unconfined compressive strength of CLSM mixes at 28 days, in accordance with ASTM D4832.
 - 5) Submit for each concrete mix trial batch the following information:
 - a) Project identification name and number (if applicable).
 - b) Date of test report.
 - c) Complete identification of aggregate source of supply.
 - d) Tests of aggregates for compliance with the Contract Documents.
 - e) Brand, type, and composition of cementitious materials.
 - f) Brand, type, and quantity of each admixture.
 - g) Quantity of water used in trial mixes.
 - h) Proportions of each material per cubic yard.
 - i) Gross weight and yield per cubic yard of trial mixtures.
 - j) Measured flowability.
 - k) Measured air content.
 - l) Unconfined compressive strength.

C. Regulatory Requirements:

- 1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:
 - a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).
- 2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. List of CLSM materials and mix designs proposed for use. Include results of quality assurance testing performed to qualify the materials and to establish the mix designs.
 - b. Laboratory Trial Batch Reports: Submit laboratory quality assurance test reports for materials and mix design tests.
 - c. Modifications to the Work proposed due to design of sheeting, shoring, bracing, cofferdams, and similar excavation supports.
- 2. Product Data:
 - a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures to be used in CLSM mixes.

- B. Informational Submittals: Submit the following:
1. Procedure Submittals:
 - a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
 - 1) Name of CONTRACTOR's "competent person" in responsible charge of excavation and fill Work.
 - 2) Excavation method(s) and additional items to be included in the Work, as listed in Paragraph 1.5.B.2.a of this Section.
 - 3) Copies of "manufacturer's data" or other tabulated data if protective system(s) are designed on the basis of such data.
 - 4) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.
 - b. Proposed compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.
 2. Excavation Support Plan and Related Information Prepared by CONTRACTOR's Professional Engineer:
 - a. CONTRACTOR and CONTRACTOR's professional engineer shall prepare the following for submittal:
 - 1) Sheet piling and bracing, or other protective system(s) required.
 - 2) Dewatering system.
 - 3) Cofferdams.
 - b. Drawings and calculations shall be prepared by professional engineer qualified in the specialty involved. ENGINEER's review and acceptance of submittal does not imply approval by ENGINEER of the associated Work. CONTRACTOR shall be solely responsible for designing, installing, operating and maintaining the system(s) required to satisfactorily perform all necessary sheet piling, bracing, protection, underpinning, and dewatering.
 3. Delivery Tickets:
 - a. Copies of delivery tickets for each load of pervious concrete and CLSM material delivered to or mixed at the Site. Each delivery ticket shall contain information in accordance with ASTM C94/C94M along with project and contract name and number, date, mix type, mix time, quantity and amount of water introduced.

1.6 SITE CONDITIONS

- A. Subsurface Information: The Supplementary Conditions indicate information available relative to subsurface conditions at the Site. Such information and data is not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by CONTRACTOR. OWNER will not be responsible for interpretations or conclusions drawn therefrom by CONTRACTOR.
- B. Soil borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER. Coordinate CONTRACTOR-performed test borings and other exploratory operations with OWNER and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of OWNER or utility owners. Comply with Laws and Regulations relative to required notifications.
- C. Existing Structures:
 - 1. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. CONTRACTOR shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by CONTRACTOR. Immediately repair and restore existing structures and Underground Facilities damaged by CONTRACTOR without additional cost to OWNER.
 - 2. Movement or operation of construction equipment over Underground Facilities shall be at CONTRACTOR's sole risk and only after CONTRACTOR has prepared and submitted to ENGINEER and utility owners (as applicable), and received acceptance therefrom, a plan describing CONTRACTOR's analysis of the loads to be imparted and CONTRACTOR's proposed measures to protect structures and Underground Facilities during the Project.
 - 3. Coordinate with utility owners for shut-off of services in active piping and conduits. When required by utility owner, OWNER will assist CONTRACTOR with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
 - 4. In general, service lines and laterals to individual houses and businesses are not shown; however, CONTRACTOR shall assume that a service exists for each utility owner to each house, business, and property.

5. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by ENGINEER after acceptable temporary utility services are provided by CONTRACTOR for the affected structure or property.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Select Fill:

1. Material shall be well-graded, crushed aggregate, free of organic material. Material shall be Item 302 in accordance with Michigan Department of Transportation.

B. General Fill:

1. Material shall be free of: rock and gravel larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious matter.
2. Fill shall have a liquid limit not greater than 45, and plasticity index not greater than 25.
3. Previously-excavated materials complying with the Contract Documents requirements for general fill may be used for general fill.
4. When on-Site materials are found unsuitable for use as general fill, provide select fill or approved off-Site general fill materials. Prior to using off-Site material as general fill, furnish submittal for and obtain ENGINEER's approval of the material proposed for use.

C. Subbase Material:

1. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Crushed slag is unacceptable. Material shall be Item 302 in accordance with Michigan Department of Transportation.

D. Drainage Fill:

1. Material shall be washed, uniformly-graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing 1.5-inch sieve and not more than five percent passing a No. 4 sieve.

E. Pipe Bedding Material:

1. Aggregate material shall be crushed stone and gravel, free of: rock or gravel larger than 1/2-inch in any dimension, debris, waste, frozen materials, organic material and other deleterious matter. Material shall be Item 302 in accordance with Michigan Department of Transportation.
2. Sand material, where required, shall consist of natural or manufactured granular material and shall contain no organic material. Sand shall be non-plastic, when tested in accordance with ASTM D4318, 100 percent shall pass a 1/2-inch screen and not more than five percent shall pass a No. 200 screen.

F. Controlled Low Strength Material (CLSM):

1. CLSM shall be self-leveling and self-compacting cementitious material.
 - a. Cement: Type I or Type II portland cement complying with ASTM C150/C150M.
 - b. Fly Ash Mineral Admixture: Comply with ASTM C618, Class F.
 - c. Water: Clean, potable.
 - d. Admixtures: Provide admixtures in accordance with product manufacturer's published instructions. Admixtures shall be compatible with each other. Do not use calcium chloride or admixtures containing chloride ions. Use only admixtures that have been tested and approved in the mix designs.
 - e. Fine Aggregates: ASTM C33/C33M.
2. CLSM Mix:
 - a. Cement Content: 50 pounds per cubic yard.
 - b. Fly Ash Mineral Admixture: 250 pounds per cubic yard.
 - c. Fine Aggregate Content: 2910 pounds per cubic yard.
 - d. Water Content: 500 pounds per cubic yard.
 - e. Admixtures shall comply with manufacturer's recommendations for use with CLSM.
 - f. Unconfined compressive strength shall be not more than 150 psi.
 - g. Adjustment of Mixes.
 - 1) Mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
 - 2) Submit for ENGINEER's approval laboratory test data for adjusted mix designs, including compressive strength test results.
 - 3) Implement adjusted mix designs only after ENGINEER's approval.
 - 4) Adjustments to mix designs shall not result in additional costs to OWNER.

2.2 SOURCE QUALITY CONTROL

- A. Perform quality assurance testing, and submit results to ENGINEER, in accordance with the "Quality Assurance" Article in Part 1 of this Section.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Provide ENGINEER with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. ENGINEER will advise CONTRACTOR in writing when ENGINEER is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 TEST PITS

A. General:

1. In advance of the construction, excavate, make observations and measurements, and fill test pits to determine conditions or location of the existing Underground Facilities and structures. Perform all work required in connection with excavating, stockpiling, maintaining, sheeting, shoring, filling, and replacing pavement for test pits. CONTRACTOR shall be responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting the affected Underground Facility or structure. CONTRACTOR shall be responsible for repairing, at his expense, damage to Underground Facility or structure caused during the Work.

3.3 PREPARATION

A. Site Preparation:

1. Clear areas to be occupied by permanent construction of all trees, brush, roots, stumps, logs, wood and other materials and debris. Clean and strip vegetation, sod, topsoil, and organic matter from subgrades where fills will be placed, and from areas where structures will be constructed. Remove from the Site and properly dispose of all waste materials.

B. Dust Control:

1. Control objectionable dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to ENGINEER's acceptance and approval of authorities having jurisdiction.

3.4 DEWATERING

A. Dewatering – General:

1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and continually thereafter until the structure to be built therein is acceptable to ENGINEER and backfilling operations are completed and acceptable to ENGINEER.
2. Keep all working areas at the Site free of surface water at all times. Provide temporary drainage ditches and temporary dikes, and provide required temporary pumping and other work necessary for diverting or removing rainfall and all other accumulations of surface water from excavations and fill areas. Perform diversion and removal of surface water in manner that prevents accumulation of water behind permanent or temporary structures and at any other locations in the construction area where such accumulations may be detrimental.

3. Water used for working or processing, resulting from dewatering operations, or containing oils or sediments that will reduce the quality of the surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin or filter before discharging to surface water, groundwater, or drainage routes.
 4. CONTRACTOR shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of sediment.
 5. Remove water from excavations as fast as water collects.
- B. Disposal of Water Removed by Dewatering System:
1. CONTRACTOR's dewatering system shall discharge to a suitable location acceptable to OWNER, in accordance with Laws and Regulations.
 2. Convey water from excavations in closed conduits. Do not use trench excavations as temporary drainage ditches.
 3. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
 4. Dispose of water in manner that causes no inconvenience to OWNER, others involved in the Project, and adjacent and downstream properties.

3.5 EXCAVATION

- A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits.
- B. Maintain excavations in dry condition in accordance with "Dewatering" Article in Part 3 of this Section.
- C. Elevation of bottom of footings shown is approximate. ENGINEER may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing.
- D. When excavations are made below required grades without written order of ENGINEER, fill such excavations with compacted select fill material, as directed by ENGINEER, at CONTRACTOR's expense.
- E. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of shoring and bracing, and the safe sloping of banks, as necessary.

F. Subgrades – General:

1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced with Item 302 in accordance with Michigan Department of Transportation. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
2. If, in ENGINEER's opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within CONTRACTOR's control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at CONTRACTOR's expense.

G. Pipe Trench Preparation:

1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.
2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
 - a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. Refer to Drawings for trench requirements. In no case should trench be wider at top of pipe than pipe barrel OD plus two feet, unless otherwise shown or indicated.
 - b. Enlargement of trench width at pipe joints may be made when required and approved by ENGINEER.
 - c. Trench width shall be sufficient for shoring and bracing, or shielding and dewatering.
 - d. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.
 - e. Do not use excavating equipment that requires the trench to be excavated to excessive width.
3. Depth of trench shall be as shown or indicated. If required and approved by ENGINEER in writing, depths may be revised.
4. Where ENGINEER considers existing material beneath bedding material unsuitable, remove and replace such unsuitable material with select fill material.

H. Excavated Materials to be Used as Fill:

1. Stockpile excavated materials that are acceptable for use as fill.
2. As excavation proceeds, keep stockpiles of excavated materials suitable for use as fill separate from unsuitable materials and waste materials.
3. Place, grade, and shape stockpiles for proper drainage.
4. Locate and retain soil materials away from edge of excavations.
5. Dispose of excess soil material and waste materials as specified in this Section.

6. Stockpiled excavated soils for use as select fill or general fill shall be tested and classified by laboratory as on-Site select fill or on-Site general fill. Perform required quality assurance testing for material verification on stockpiled materials as soon as possible to demonstrate compliance of excavated materials with the Contract Documents.

3.6 UNAUTHORIZED EXCAVATION

- A. All excavations outside lines and grades shown or indicated and that are not approved by ENGINEER, together with removing and disposing of the associated material, shall be at CONTRACTOR's expense. Fill unauthorized excavations with properly-compacted select fill material at CONTRACTOR's expense.

3.7 EROSION AND SEDIMENT CONTROLS

- A. Provide temporary erosion and sediment controls in accordance with Section 01 57 05, Temporary Controls. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction.

3.8 SHEETING, SHORING, AND BRACING

- A. General:
 1. Design and provide sheeting, shoring, bracing, cofferdams, and similar excavation supports as shown, specified, and required for the Work.
 2. Clearances and types of temporary sheeting, shoring, bracing, and similar excavation supports, insofar as they may affect the finished character of the Work and the design of sheeting to be left in place, will be subject to the ENGINEER's approval; but CONTRACTOR is responsible for adequacy of all sheeting, shoring, bracing, cofferdams, and similar excavation supports.
 3. Materials:
 - a. Previously-used materials shall be in good condition, and shall not be damaged or excessively pitted. All steel or wood sheeting designated to remain in place shall be new. New or used sheeting may be used for temporary sheeting, shoring, and bracing.
 - b. All steel work for sheeting, shoring, bracing, cofferdams and other excavation supports, shall be in accordance with ANSI/AISC 360, except that field welding will be allowed.
 4. As excavation progresses, carry down shoring, bracing, cofferdams, and similar excavation supports to required elevation at bottom of excavation.
 5. Comply with Laws and Regulations regarding sheeting, shoring, bracing, cofferdams, and similar excavation supports.
 6. Maintain sheeting, shoring, bracing, and other excavation supports in excavations regardless of time period excavations will be open.
 7. Unless otherwise shown, specified, or directed, remove materials used for temporary construction when the Work is completed. Perform such removal in manner not injurious to the structures and Underground Facility, their appearance, and adjacent construction.

- B. Removal of Sheeting and Bracing:
 - 1. Remove sheeting and bracing from excavations, unless otherwise directed by ENGINEER in writing. Perform removal to avoid damaging the Work and adjacent construction. Removal shall be equal on both sides of excavation to ensure no unequal loads on structures and Underground Facilities.
 - 2. Defer removal of sheeting and bracing, where removal may cause soil to come into contact with concrete, until the following conditions are satisfied:
 - a. Concrete has cured for not less than seven days.
 - b. Wall and floor framing, up to and including grade level floors, is in place.

3.9 TRENCH SHIELDS

- A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.
- B. When using a shield for installing piping:
 - 1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe's mid-diameter elevation prior to moving the shield along the trench for further construction.
 - 2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.
- C. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.
- D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.10 FILL AND COMPACTION – GENERAL PROVISIONS

- A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.
- B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
 - 1. ENGINEER's authorization after observation of construction below finish grade, including dampproofing, waterproofing, perimeter insulation, and similar Work.
 - 2. Inspection, testing, approval, and recording of locations of Underground Facilities.
 - 3. Removal of concrete formwork.

4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
 5. Removal of trash and debris.
 6. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.
 7. Field testing of tanks, Underground Facilities including piping and conduits, and water-retaining structures.
- C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.
- D. Placement – General:
1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
 2. Fill areas shall be undercut and proof-rolled as directed by ENGINEER.
 3. Place fill materials at moisture content and density as specified in Table 31 23 05-A of this Section and this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.
 4. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 7,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and Underground Facilities. Effectiveness of the equipment selected by CONTRACTOR shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.

5. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface. Compaction of fill materials by inundation with water is unacceptable.
6. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
7. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly-functioning compaction equipment, CONTRACTOR shall perform all work required to provide the required densities. Such work shall include, at no additional cost to OWNER, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
8. Repair, at CONTRACTOR's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by ENGINEER.

E. Fill Against Concrete:

1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 00 05, Concrete.
2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Electrical Ductbank Trenches:

1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
2. Placing and compacting fill in electrical ductbank trenches shall comply with requirements of Paragraph "G. Fill in Pipe Trenches", of this Article.

G. Fill in Pipe Trenches:

1. Place pipe bedding material in pipe trenches in horizontal layers, and thoroughly compact each layer before the next layer is placed.
2. Piping Installed in Fills Above Pre-construction Grade:
 - a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
3. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
4. Pipe Bedding: Pipe bedding material shall be as follows:
 - a. Install PVC, CPVC, HDPE, and FRP piping on a layer of sand. Sand shall extend to 12 inches above top of pipe and to the trench walls on each side of the pipe.
 - b. Unless otherwise shown, install other types of piping on not less than six-inch layer of aggregate pipe bedding material. Aggregate pipe bedding material shall extend 12 inches above top of the pipe.
5. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
 - a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
 - b. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of the pipe and back of the bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.
 - c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.
 - d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

H. Temporary Pavement:

1. Place 1.5 inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
3. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

I. Subbase Placement:

1. Provide subbase material where shown to the limits shown or indicated.
2. Place subbase material in compacted lifts not exceeding depth of six inches each.

J. Drainage Fill Placement:

1. Provide drainage fill material where shown to the limits shown or indicated.
2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.

K. Compaction Density Requirements:

1. Compaction required for all types of fills shall be in accordance with Table 31 23 05-A of this Section. Moisten material or aerate the material as necessary to provide the moisture content that will facilitate obtaining the required compaction.

**TABLE 31 23 05-A
REQUIRED MINIMUM DENSITY**

Material	Percent Compaction (ASTM D698)	Uncompacted Lift (inches)
General Fill		
More than five feet below final grade	100	8
Less than five feet below final grade	95	8
Select Fill		
Below concrete slabs or mats	100	8
Below pavement and sidewalks	100	12
Behind concrete walls	95	8
Subbase Material		
Below pavement and sidewalks	100	12
All other locations	100	8
Pipe Bedding Material		
Below structures or pavement	100	8
All other locations	95	6
Drainage Fill	N/A	6

2. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
 - a. On-site clayey soils: Optimum to plus three percent.
3. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated in Table 31 23 05-A of this Section.
4. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work. Responsibility for field quality control testing is specified in the "Field Quality Control" Article in Part 3 of this Section.
5. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to OWNER until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by ENGINEER) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

- L. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with Table 31 23 05-A and the associated "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.11 GRADING

A. General:

1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:

1. Grassed Areas or Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below the required subgrade elevations.
2. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below the required subgrade elevation.
3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

- C. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten foot straight edge.
- D. Compaction:
 - 1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.12 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. Controlled Low Strength Materials Placement:
 - 1. Discharge CLSM from the mixer by reasonable means into the space to be filled.
 - 2. Bring the fill material uniformly up to the fill line shown or indicated in the Contract Documents.
 - 3. Placement of fill over the CLSM may proceed after a curing period of not less than three days.

3.13 DISPOSAL OF EXCAVATED MATERIALS

- A. General:
 - 1. CONTRACTOR shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
 - 2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to OWNER.

3.14 TEMPORARY BARRIERS

- A. Provide temporary barrier surrounding excavations and excavation work areas to provide temporary protection to persons and property. Barrier shall have openings only at vehicular, equipment, and worker access points.
- B. Minimum Material Requirements for Temporary Barriers:
 - 1. Temporary barrier shall not be less snow fence-type fencing, four feet high.
 - 2. Fence shall be constructed of vertical hardwood slats measuring not less than 1.5 inches by 1/4-inch interwoven with strands of horizontal wire, or shall be of equivalent plastic construction.
 - 3. Posts:
 - a. Posts shall be steel, either "U"-, "Y"-, "T"-shaped, or channel section.
 - b. Posts shall have a nominal weight of not less than 1/3-pound per linear foot, exclusive of the anchor.
 - c. Posts shall have tapered anchors weighing not less than 0.67 pounds, each firmly attached by means of welding, riveting or clamping.
 - d. Posts shall have corrugations, knobs, notches, or studs placed and constructed to engage a substantial number of fence line wire in the proper position.

- e. Provide each post with sufficient quantity of galvanized wire fasteners or clamps, of not less than 0.120-inch diameter, for attaching fence wire to post.

3.15 FIELD QUALITY CONTROL

- A. Site Tests: Employ a testing laboratory to perform field quality control testing.
 - 1. Testing Laboratory Scope:
 - a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
 - b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
 - c. Report results of each test to ENGINEER and CONTRACTOR.
 - 2. Required Material Tests:
 - a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
 - 3. Authority and Duties of Testing Laboratory:
 - a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to ENGINEER and CONTRACTOR. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of ENGINEER and CONTRACTOR to such failure.
 - b. Technician will not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate ENGINEER for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.
 - 4. Responsibilities and Duties of CONTRACTOR:
 - a. Use of testing laboratory shall in no way relieve CONTRACTOR of the responsibility to provide materials and Work in full compliance with the Contract Documents.
 - b. To facilitate testing laboratory, CONTRACTOR shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
 - c. It shall be CONTRACTOR's responsibility to accomplish the specified compaction for fill and other earthwork. CONTRACTOR shall control construction operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the Contract Documents relative to compaction, control.

- d. CONTRACTOR shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.
 - 1) 200 linear feet of trench fill.
 - 2) 10 cubic yards of select fill.
 - 3) 100 cubic yards of general fill.
 - 4) 50 cubic yards of subbase material.
- 5. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be taken as follows:
 - a. Trenches for Structures, and Underground Facilities (including buried ductbanks):
 - 1) In Open Fields: Two locations every 1,000 linear feet.
 - 2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
 - 2) Crossing Paved Roads: Two locations along each crossing.
 - 3) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
 - b. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.
 - c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.
 - d. For General Fill: One per 1,000 square feet on every compacted lift.
 - e. Subbase Material: One per 1,000 square feet on every compacted lift.
- 6. Periodic compliance tests will be made by ENGINEER to verify that compaction is complying with the requirements specified, at no cost to CONTRACTOR. CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall fill and re-compact the excavation after testing is complete.
- 7. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, CONTRACTOR shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at CONTRACTOR's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade, fills, or bedding materials that did not originally comply with specified density shall be paid by CONTRACTOR.

+ + END OF SECTION + +

SECTION 32 12 00

FLEXIBLE PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install flexible, hot-mix, hot-laid, asphalt concrete pavement.
 - 2. The Work includes:
 - a. Providing asphalt concrete paving materials.
 - b. Providing quality controls and testing.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before flexible paving Work.
- C. Related Sections:
 - 1. Section 31 23 05, Excavation and Fill.
 - 2. Section 32 16 13, Concrete Sidewalks.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. MDOT Standard Specifications for Construction.
 - a. Division 3: Bases
 - 1) Section 302 Aggregate Base Course.
 - 2) Section 306 Aggregate Surface Course and Maintenance Gravel
 - b. Division 5: Hot Mix Asphalt Pavements and Surface Treatments
 - 1) Section 501 Plant-Produced Hot Mix Asphalt
 - 2) Section 502 HMA Crack Treatment
 - c. Division 9: Materials
 - 1) Section 902 Aggregates
 - 2) Section 904 Asphaltic Materials
 - 2. American Society for Testing and Materials (ASTM):
 - a. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Asphalt Concrete Production Facility:
 - a. Production facility for asphalt concrete, tack coat materials, and other bitumastic materials shall be certified by the MDOT for furnishing such materials for MDOT highways.

2. CONTRACTOR's Testing Laboratory:
 - a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of the materials provided under this Section.
 - b. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
 - c. Testing laboratory shall be experienced in the types of testing required.
 - d. Selection of testing laboratory is subject to ENGINEER's acceptance.
- B. Regulatory Requirements:
 1. Reference Specifications and Details:
 - a. Comply with applicable requirements of Michigan Department of Transportation.
 2. Obtain required highway and street rights-of-way work permits.
 3. Jurisdiction: Paved areas to be constructed are jurisdiction of Lenawee County Road Commission.
- C. Quality Assurance Testing:
 1. Quality assurance testing is in addition to source quality control testing, when required.
 2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
 3. CONTRACTOR's Quality Assurance Testing Laboratory Scope:
 - a. Use of testing laboratory shall not relieve CONTRACTOR of responsibility for providing materials and the Work in compliance with the Contract Documents.
 - b. Quality assurance testing laboratory shall perform the following, unless evidence of material compliance with reference specifications indicated in Paragraph 1.3.B. of this Section, is submitted to ENGINEER by CONTRACTOR and asphalt concrete production facility:
 - 1) Test in accordance with reference specifications indicated in Article 1.3 of this Section. In lieu of quality assurance testing, submit evidence and certification of material compliance with reference specifications. When evidence of conformance submitted is not acceptable to ENGINEER, perform quality assurance testing.
 - c. To facilitate testing services, CONTRACTOR shall:
 - 1) Secure and deliver to testing laboratory and ENGINEER (when requested by ENGINEER) representative Samples of materials that CONTRACTOR proposes to furnish and that are required to be tested.
 - 2) Furnish such labor as is necessary to obtain and handle Samples at the Site or at asphalt concrete production facility and other material sources.

- 3) Advise testing laboratory and ENGINEER sufficiently in advance of operations to allow for completion of quality assurance tests and for the assignment of personnel.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Submit the proposed asphalt concrete mix design for each asphalt concrete material, and other bituminous materials, required under this Section, providing complete data on materials, including location in the Work, source, material content and percentages, temperatures and all other pertinent data. Indicate proportion of bituminous material from reclaimed asphalt pavement.
 - b. Proposed gradation for each aggregate to be used in flexible paving. Submit gradation test results for the same material furnished on a previous project. Indicate the proportion of reclaimed asphalt pavement.
2. Product Data:
 - a. Manufacturer's complete product data on all pavement marking materials proposed for use, including product literature, specifications, and recommended application techniques and other installation data.

B. Informational Submittals: Submit the following:

1. Quality Assurance Test Data Submittals and Source Quality Control Submittals:
 - a. Submit for quality assurance tests and source quality control tests required.
2. Delivery Tickets:
 - a. Submit copy of delivery ticket for each load of asphalt concrete, tack coat materials, and other materials obtained from asphalt concrete production facility, signed by CONTRACTOR
3. Field Quality Control Submittals:
 - a. Submit results of required field quality control testing.
4. Qualifications:
 - a. Asphalt concrete production facility, when required by ENGINEER.
 - b. CONTRACTOR's testing laboratory, when required by ENGINEER.

1.5 SITE CONDITIONS

A. Weather Limitations:

1. Temperature:
 - a. For base course and binder course paving lifts equal to or greater than two inches thickness, atmospheric temperature shall be 40 degrees F and rising.
 - b. For surface course paving or other pavement courses in lifts less than two inches thick, temperature of surface on which pavement is to be placed shall be 50 degrees F or greater.

2. Prohibitions:
 - a. Do not place flexible paving materials when weather is foggy or during precipitation.
 - b. Do not place flexible paving materials when the base on which the material will be placed contains moisture in excess of optimum.
 - c. Place flexible paving materials only when ENGINEER concurs that weather conditions are suitable.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. System Description:
 1. Provide subbase course of the thickness shown or indicated, in accordance with Section 31 23 05, Excavation and Fill.
 2. Gravel Drives:
 - a. Provide Base Course as indicated below, minimum 12 inches compacted thickness.
 3. Asphalt Pavement Courses:
 - a. Provide the flexible pavement courses indicated below:
 - 1) Base Course: 8 inches compacted thickness.
 - 2) Surface Course (Wearing Course or Top Course): 4 inches compacted thickness.

2.2 GRAVEL DRIVES

- A. Gravel Drives: Provide the following materials designed and manufactured in accordance with reference specifications indicated in Article 1.2.A. of this Section:
 1. Base Course: Type 21AA base course complying with Section 306 of the MDOT Standard Specifications for Construction.

2.3 ASPHALT CONCRETE MIXES

- A. Asphalt Concrete Mixtures: Provide the following materials designed and manufactured in accordance with reference specifications indicated in Article 1.2.A. of this Section:
 1. Base Course: Type 21AA base course complying with Section 302 of the MDOT Standard Specifications for Construction.
 2. Surface Course (Wearing Course, Top Course): Type 5E1 hot-mix asphalt top course complying with Section 501 of the MDOT Standard Specifications for Construction.

2.4 BITUMINOUS MATERIALS

- A. Bituminous Materials for Asphalt Concrete:
 - 1. Bituminous materials for asphalt concrete shall comply with the reference specifications indicated in Article 1.2.A. of this Section, for the asphalt concrete mixes specified.
- B. Tack Coat:
 - 1. Tack coat shall be emulsified asphalt.
 - 2. Provide tack coat complying with ASTM D977, Type SS-1H.
- C. Crack Sealant:
 - 1. Provide one of the following products in compliance with reference specifications indicated in Article 1.2.A. of this Section:
 - a. Sealtight 3405 as manufactured by W.R. Meadows.
 - b. Or equal.

2.5 AGGREGATES IN FLEXIBLE PAVEMENTS

- A. Aggregates for Asphalt Concrete – General:
 - 1. Aggregate materials used in flexible pavement shall be in accordance with the reference specifications indicated in Article 1.2.A. of this Section, for the asphalt concrete mix designs indicated.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine the subbase and base on which flexible paving will be installed. Notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.
- B. Do not place materials on subgrades, or subbase that is muddy or has water thereon.

3.2 PREPARATION

- A. Preparation: Before starting installation of flexible paving, perform the following:
 - 1. Grade Control: Establish and maintain throughout flexible paving installation the required lines and grades, including crown and cross-slope for each asphalt concrete course during construction operations.
 - 2. Prepare subgrade and provide subbase for flexible pavement in accordance with Section 31 23 05, Excavation and Fill. Before installing flexible pavement, obtain ENGINEER's concurrence that subgrade and subbase are suitable for installing flexible pavement.

3. Coordinate placement of flexible pavement with the Work included under Section 32 16 13, Concrete Sidewalks, and Work including drainage structures, manholes, valve boxes, and similar items.
4. Provide appropriate maintenance and protection of traffic measures during placement of pavement.

B. Surface Preparation:

1. Repair surface defects in existing pavement to provide uniform surface to receive new pavement.
2. Provide crack sealant to completely fill cracks more than 1/16-inch wide in areas shown or indicated on the Drawings.
3. Clean existing surfaces over which asphalt concrete pavement will be installed, by removing from the surface foreign material, excess asphalt concrete, excess joint sealant, and crack filler, and other undesirable matter.
4. Provide tack coat as indicated in Article 3.4 of this Section.

3.3 INSTALLATION OF GRAVEL DRIVES

A. General:

1. Provide a uniform aggregate base course mixture, compacted in place to a uniform density full depth.
2. Place gravel drives at locations shown on the Drawings or as directed by ENGINEER.
3. Do not place aggregate on unstable surfaces, as determined by ENGINEER. Maintain the aggregate in a smooth and stable condition until removed, surfaced, or project completion.

B. Installation of Gravel Drives:

1. Spread aggregate by means of self-propelled mechanical spreading equipment.
2. Compact the aggregate layers to a uniform thickness no greater than 8 inches unless approved in writing by ENGINEER.

3.4 INSTALLATION OF FLEXIBLE PAVING

A. General:

1. Provide final pavement surfaces of uniform texture, at required grades and cross-sections.
2. Construct roadways to the lines, grades, and typical sections shown or indicated.

B. Installation of Asphalt Concrete:

1. Asphalt concrete mixture shall be transported to the site of paving and placed as soon as possible after mixing.
2. Placement of each asphalt concrete course shall be completed over the full width of the section under construction during each day's paving operations.

3. Spread and finish asphalt concrete courses by means of self-propelled mechanical spreading and finishing equipment. Compacted thickness of layers placed shall not exceed 150 percent of specified thickness unless approved in writing by ENGINEER.
4. Compaction:
 - a. Rollers:
 - 1) Use sufficient rolling equipment to satisfactorily compact and finish the quantity of asphalt concrete placed. There shall be not less than two rollers on the Project at all times. When acceptable to ENGINEER, one of the rollers may be a pneumatic-tire roller.
 - 2) During rolling operations, roller speed shall not exceed three miles per hour. When sufficient number of rollers is not available, reduce the quantity of asphalt concrete placed to accommodate the available rollers' speed.
 - 3) Required rollers shall be at the Site, in acceptable operating condition, prior to placing of asphalt concrete.
 - 4) Use of vibratory rollers in lieu of steel-wheeled rollers is acceptable, however when thickness of asphalt concrete is one-inch or less, rolling shall be in the static mode.
 - b. Rolling of initially-placed asphalt concrete material, or breakdown rolling, shall begin as soon as the asphalt concrete mixture will bear the roller without undue displacement.
 - c. Rolling shall be longitudinal, overlapping on successive trips by not less than one-half roller rear wheel width, and not more than three-quarters of roller rear wheel width. Alternate trips of the roller shall be of slightly different lengths.
 - d. At all times, roller motion shall be slow enough to avoid displacing the asphalt concrete.
 - e. Operate rollers continuously from breakdown of laid asphalt concrete through finish rolling.
 - f. Perform finish rolling using a steel-wheeled roller or a vibratory steel-wheel roller operating in the static mode.
 - g. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.
 - h. At each location not accessible to roller, thoroughly compact asphalt concrete with tampers and finish, where necessary, with a hot smoothing iron to provide uniform, smooth layer over the entire area so compacted.
5. Each compacted asphalt concrete course shall be within plus or minus 1/4-inch of the indicated thickness.

C. Joining of Pavements:

1. When pavement is to join existing or previously-laid pavement, the existing or previously-laid pavement shall be neatly and carefully edged to allow for overlapping and feathering of the subsequent course of asphalt concrete material.
2. Where new pavement is to meet existing pavement, the existing pavement shall be sawcut and notched.

3. Where new pavement will meet existing asphalt pavement, remove existing pavement 12 inches onto undisturbed existing pavement course at edges where new pavement will meet existing pavement.
4. Tack Coat:
 - a. Provide tack coat material at the following locations:
 - 1) At edges where new pavement will connect to existing or previously-installed pavement.
 - 2) On surface of existing or previously-installed pavement course over which new pavement will be installed, prior to placement of the subsequent pavement course. Tack coat may be deleted when a succeeding layer of asphalt pavement is being applied over a freshly-placed asphalt pavement course that has been subjected to very little or no traffic, with approval of ENGINEER
 - 3) Where new pavement will abut curbing, concrete gutters, drainage structures and frames, manhole cover frames, valve boxes, and similar items.
 - b. Tack Coat Installation: Install tack coat immediately prior to installing pavement. Place pavement while tack coat is wet. Apply tack coat in accordance with reference specification indicated in Article 1.3 of this Section.

D.

D. Curing:

1. Do not allow traffic onto pavement until directed by ENGINEER. Traffic will not be allowed on new asphalt concrete pavement until surface temperature is less than 140 degrees F.
2. Hold construction traffic on new pavement to a minimum as acceptable to ENGINEER.

E. Asphalt Concrete Curbs: Provide extruded asphalt curbs of the height and profile indicated on the Drawings.

F. Defective Pavement Work:

1. When directed by ENGINEER, remove and replace defective flexible paving Work. Cut out such areas of defective pavement and fill with fresh asphalt concrete materials, compacted to required density.

3.5 ADJUSTING

A. Frames and Covers:

1. Set frames of drainage structures, manholes, valve boxes, and similar items to final grade. Adjust frames of existing structures and frames furnished under other Sections. Frames shall be substantially similar elevation to finished surface course of pavement.
2. Replace covers and gratings of existing structures immediately following adjusting associated frames. Install covers and gratings of structures provided under the Project as quickly as possible.

3. Where there is a delay between adjusting of frames and installation of surface course, provide temporary bituminous material around perimeter of each frame to smooth vehicle access over the frame. Maintain and repair temporary bituminous material as required until placement of surface course. Remove temporary bituminous material before installing surface course.

B. Pavement Adjustment:

1. Repair or replace in manner acceptable to ENGINEER areas of pavement that are observed to pond or collect water.

3.6 CLEANING

- A. Cleaning: After completing the paving operations, clean surfaces of excess or spilled bituminous materials, excess asphalt concrete, and foreign matter.

3.7 PROTECTION

- A. Protect finished pavement until pavement has become properly hardened and cool.
- B. Cover openings of drainage structures, manholes, valve boxes, and similar items in the paved area until permanent coverings are provided.

+ + END OF SECTION + +

SECTION 32 16 13

CONCRETE SIDEWALKS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete sidewalks.
 - 2. Types of Work required under this Section include:
 - a. Conventionally-formed sidewalk.
 - 3. Width, thickness, geometry, and extent of curb, gutter, and sidewalk shall be as shown or indicated on the Drawings.
 - 4. Requirements for concrete sidewalks apply to concrete driveways, unless otherwise shown or specified, or unless concrete pavement requirements are included in the Contract Documents.
- B. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 07 92 00, Joint Sealants.
 - 3. Section 31 23 05, Excavation and Fill.

1.2 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Installer:
 - a. Installer shall have not less than two years experience installing concrete sidewalks similar to those required for the Work.
 - b. When required by ENGINEER, submit record of experience documenting not less than three successful, completed projects. For each project, submit name the following information: project name, location of project, approximate quantity of concrete curb, gutter, and sidewalk constructed by installer, contract price of concrete curb, gutter, and sidewalk construction, and name and contact information for project owner and the project's construction-phase engineer.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Submit concrete mix design when mix design is different from that submitted under Section 03 00 05, Concrete. Submit in accordance with Section 03 00 05, Concrete.

2. Product Data:
 - a. Concrete Materials: Submit Supplier's technical information for materials proposed for use, when concrete materials are different from those submitted under Section 03 00 05, Concrete .
 - b. Expansion Joint Filler: Submit Supplier's technical information, including manufacturer's product data, brochure, and specifications, for materials proposed for use, when materials are different from those submitted under Section 03 00 05, Concrete .

B. Informational Submittals: Submit the following:

1. Certifications:
 - a. When concrete materials are different from those approved under Section 03 00 05, Concrete , submit certifications as required in Section 03 00 05, Concrete.
2. Site Quality Control Submittals:
 - a. Concrete test results for the Work included under this Section.
3. Qualifications Statements:
 - a. Installer, when requested by ENGINEER.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 03 00 05, Concrete.

1.5 SITE CONDITIONS

- A. Weather and Temperature Limitations:
1. When temperature and environmental conditions warrant, comply with requirements for cold weather placing and hot weather placing under Section 03 00 05, Concrete, unless otherwise required under this Section.
 2. Discontinue concrete placing when the air temperature falls below 39 degrees F. Do not place concrete in the rain.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete Materials:
1. Comply with applicable requirements of: Section 03 00 05, Concrete; including requirements for formwork, concrete materials, admixtures, bonding materials, curing materials, and others as required.
 2. Concrete Mix, Design, and Testing:
 - a. Comply with applicable requirements of Section 03 00 05, Concrete, for concrete mix design, sampling, and testing, and quality control.
 - b. Design the mix to produce concrete of properties of compressive strength, slump range, and air content as specified in Section 03 00 05, Concrete.

- B. Expansion Joint Material:
 - 1. Preformed Expansion Joint Filler: Comply with Section 03 00 05, Concrete.
 - 2. Joint Sealant: For joint sealants and accessories used on expansion joints, comply with Section 07 92 00, Joint Sealants.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine subgrade, subbase, and conditions under which the Work is will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are been corrected.
- B. Subgrade:
 - 1. Verify that earthwork is completed to correct line and grade.
 - 2. Verify that subgrade is smooth, properly compacted, and free of frost and excessive moisture in accordance with Section 31 23 05, Excavation and Fill .
 - 3. Do not commence the Work under this Section until conditions are satisfactory.

3.2 CONSTRUCTION OF FORMS

- A. Conventional Forms:
 - 1. Set forms to line and grade. Forms shall be free from warp.
 - 2. Install forms along full length of sidewalk.
 - 3. Forms shall extend to the full depth of the sidewalk and be secured so no displacement occurs during concrete placing.

3.3 CONCRETE PLACING

- A. General:
 - 1. Comply with Section 03 00 05, Concrete , and this Section relative to mixing and placing concrete.
- B. Placing:
 - 1. Sidewalks: Place concrete in one-course, monolithic construction, for full width and depth of sidewalk.

3.4 JOINTS

- A. General:
 - 1. Provide expansion joints, contraction joints, and construction joints in concrete sidewalks.
 - 2. Provide expansion, contraction, and construction joints perpendicular to formed faces of sidewalk.

- B. Contraction Joints: Provide joints as indicated below:
 - 1. Sidewalks: Provide at intervals of five feet on centers. Joint shall be not less than 1/8-inch and not more than 1/4-inch in width, and have a depth of not less than one-third the total thickness of concrete sidewalk.
 - 2. Joints may be formed or sawcut.
- C. Construction Joints: Place construction joints at locations where concrete placing operations are stopped for more than 30 minutes, except where such pours terminate at expansion joints.
- D. Expansion Joints:
 - 1. General: Provide preformed expansion joint filler at locations indicated. When sidewalk is not poured monolithically, provide expansion joints where each abuts the other.
 - 2. Sidewalks: Provide 1/2-inch wide preformed expansion joint filler at 30-foot intervals along length of sidewalk and at all joints between sidewalk and: curb, gutters, pavement, buildings, drainage structures, utility metal appurtenances such as manhole cover frames and valve boxes, and similar construction.
 - 3. Place top of expansion joint material not less than 1/2-inch or more than one-inch below concrete surface. Apply joint sealer on top of expansion joint material flush with concrete surface, and in accordance with sealant manufacturer's instructions and Section 07 92 00, Joint Sealants.

3.5 CONCRETE FINISHING

- A. Smooth exposed surface by screeding and floating. Perform hand-screeding when conventionally-formed concrete is provided.
- B. Work edges of sidewalks and transverse joints; and round to 1/4-inch radius.
- C. Complete surface finishing by drawing a fine-hair broom across surface, perpendicular to line of traffic.

3.6 CURING

- A. General:
 - 1. Protect and cure finished concrete sidewalks, in accordance with Section 03 00 05, Concrete.
 - 2. Cure sidewalks at driveways for not less than three days prior to opening to vehicle traffic. In colder weather, as indicated in Article 1.6 of this Section, curing period shall be not less than six days prior to opening to vehicle traffic unless other provisions to determine strength are provided and approved by ENGINEER.

3.7 REPAIR AND CLEANING

- A. Repair or replace broken or defective sidewalk as directed by ENGINEER.
- B. Sweep the concrete sidewalk Work and wash free of stains, discolorations, dirt, and other foreign material.

+ + END OF SECTION + +

SECTION 32 92 00

LAWNS AND MEADOWS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install all lawns and meadows.
 - 2. Extent of lawns and meadows is shown.
 - 3. Types of products required include the following.
 - a. Topsoil.
 - b. Lawn grass seed.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, lawns and meadows.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. Association of Official Analytic Chemists, (AOAC).
 - a. Official Methods of Analysis of AOAC International.
 - 2. Association of Official Seed Analysts, (AOSA).
 - a. Journal of Seed Technology; Rules for Testing Seeds.
 - 3. American Society for Testing and Materials, (ASTM).
 - a. ASTM D 75, Practice for Sampling Aggregates.
 - b. ASTM D 422, Test Method for Particle Size Analysis of Soil.
 - c. ASTM D 5268, Specification for Topsoil Used for Landscape Purposes.
 - d. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
 - e. ASTM E 548, Guide for General Criteria Used for Evaluating Laboratory Competence.

1.3 DEFINITIONS

- A. The term “finish grade” shall be used to describe the finished surface elevation of planting soil.
- B. The term “manufactured topsoil” shall be used to describe soil produced off-Site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil acceptable as a component of loam.

- C. The term “loam” shall be used to describe topsoil that has been mixed with additional organic and inorganic additives, as specified.
- D. The term “percentage pure live seed” shall be defined as the percent (%) purity multiplied by percent (%) germination divided by 100 to equal the percent pure live seed (PLS) and shall be calculated for all seed lots using each seed lot's own unique purity and germination test results. A PLS pound shall be defined as the bulk weight of seed required to equal one pound of 100 percent pure, germinated seed.
- E. The term “subgrade” shall be used to describe the surface of subsoil remaining after completing excavation; or the top surface of a fill or backfill immediately beneath topsoil and which has not been tested for acceptable use as topsoil.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Engage a single landscape installer skilled, trained and with successful and documented experience in the planting of lawns and meadows and with specific skill and successful experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work. Submit names and qualifications to ENGINEER along with the following information on a minimum of three successful projects:
 - a. Names and telephone numbers of owner, architects or engineers responsible for projects.
 - b. Approximate contract cost of the lawns and meadows.
 - c. Amount of area installed.
 - 2. Installer's Site Supervisor: Require installer to maintain an experienced full-time landscape supervisor on-Site during the time of preparation for, and planting of, lawns and meadows. Supervisor shall have achieved landscape or horticultural certification acceptable to governing authorities having jurisdiction at the Site.
 - 3. Ratio of laborers to certified landscape supervisors shall not exceed 12 to one. Certified landscape supervisor shall be on-Site throughout the day-to-day performance of the Work of this Section.
 - 4. Application of herbicides, chemicals and insecticides shall be done by personnel licensed to perform such applications by governing authorities having jurisdiction at the Site and in accordance with each manufacturer's instructions provided on each product label.
- B. Soil-Testing Laboratory Qualifications:
 - 1. An independent laboratory, recognized by governing authorities having jurisdiction at the Site, with the experience and capability to conduct testing indicated and that specializes in types of soil tests to be performed.

2. To qualify for approval, an independent testing agency shall demonstrate to ENGINEER'S satisfaction, based on evaluation of criteria submitted by testing agency, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work, in accordance with ASTM E 329 and as documented according to ASTM E 548.
- C. References: Comply with the applicable requirements referenced in Section 01 42 00, References.
- D. Soil Analysis: Furnish report of soil analysis to ENGINEER, prepared by a qualified soil-testing laboratory, stating percentages of organic matter; mechanical gradation of sand, silt, and clay content in compliance with ASTM D 422; cation exchange capacity; sodium absorption ratio; deleterious materials content; pH; and mineral and plant-nutrient content of soil. Chemical analysis shall include tests for percentages of nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, calcium, iron, manganese, copper, zinc, extractable aluminum, and total soluble salts.
1. Existing On-Site Soil:
 - a. Separate soil stockpiled and proposed for use as topsoil for lawns and meadows into 1000 cubic yard piles and label with a numbering system used to reference all soil samples and test results.
 - b. Obtain a one cubic foot representative sample for each 1000 cubic yards of soil stockpiled on-Site proposed for use as topsoil for lawns and meadows, in compliance with ASTM D 75 and Appendixes, for securing samples from stockpiles.
 - c. Place samples taken from each stockpile, into separate clean, new and previously unused, containers and mix thoroughly. Maintain separation and legible labeling of each sample taken from each stockpile, throughout the process of mixing, drying and delivering to soil analysis laboratory. Label samples on outside of container.
 - d. Take one cup of soil from each container and allow to dry at room temperature. Once dry, place each one-cup sample in a separate, accurately labeled, new and previously unused one-cup sized plastic container, seal tightly and deliver to soil testing laboratory.
 - e. Report suitability of soil as a topsoil component for lawn and meadow plant growth. State recommended quantities of nitrogen, phosphorus, secondary and micronutrients, potash and soil amendments to be added to produce satisfactory topsoils. Include calculations, types of fertilizer and recommendations for application rates in either gallons or pounds per cubic foot of soil.
 - f. In addition, all on-Site soil that will be used as topsoil shall be provided with additional compost and peat moss amendments specified, whether or not testing indicates positive need for such amendments, for such material to be used as loam.

- E. Source Quality Control:
 - 1. Analysis and Standards: Package all products with manufacturer's certified analysis performed in accordance with methods established by AOAC, wherever applicable, or as specified.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Schedule for lawn and meadow-planting showing anticipated planting dates for each type of Work.
 - 2. Product Data:
 - a. Manufacturer's product data, specifications and installation instructions for all required materials.
 - b. Composition and analysis of commercial fertilizers and all purchase receipts showing the total quantity actually purchased for this Project.
 - c. Proportions of each component contained in hydro seed mixture. Identify number of pounds of each component required for each 100 gallons of water. Include the number of square feet of lawn, grass meadow or wildflower meadow mixture that can be installed with each full tank of hydro seed mixture.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certification of Grass and Wildflower Seed: For each grass-seed monostand and seed mixture, furnish seed supplier's certification stating the botanical and common name, and percentage by weight of each species and variety, and percentage of purity, germination and weed seed. Include the year of production and date of packaging. Certify that seed has been stored in compliance with all recommendations of the seed supplier.
 - b. Certificates of inspection as may be required by governmental authorities to accompany shipments, and manufacturer's certified analysis for soil amendments and fertilizer materials. For standard products submit other data substantiating that materials comply with specified requirements.
 - 2. Test Reports: Submit the following:
 - a. Soil analysis reports for existing soil and imported manufactured topsoil, as specified. Include recommendations for remediating existing soil into acceptable topsoil.
 - 3. Qualifications Data: Submit qualifications data for the following:
 - a. Landscape installer.
 - b. Landscape supervisor.
 - c. Testing agency.

- C. Closeout Submittals: Submit the following:
 - 1. Operations and Maintenance Data:
 - a. Submit recommended procedures to be established by OWNER for the maintenance of lawns and meadows for one full year. Submit prior to expiration of required maintenance period.
 - 2. Warranty Documentation:
 - a. Submit written warranty, signed by CONTRACTOR and landscape installer, as specified.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Delivery of Materials:
 - 1. Do not deliver seed, sprigs, plugs or sod until Site conditions are ready for installation.
 - 2. Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery.
 - 3. Deliver seed in undamaged, original containers, sealed by the supplier and indicating compliance with approved Shop Drawings.
 - 4. Inspect lawn and meadow materials upon arrival at Site. Immediately and permanently remove unacceptable materials from Site.
- B. Storage of Materials:
 - 1. Store and cover materials to prevent deterioration. Remove packaged materials that become wet or show deterioration or water marks from the Site.
 - 2. Seed that becomes wet, moldy or damaged during the time of storage on-Site or that has been damaged during transit is not acceptable.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Proceed with and complete lawn and meadow planting as rapidly as portions of the Site become available, working within the seasonal limitations for each type of lawn, grass and wildflower planting required.
 - 2. Proceed with planting only when current and forecasted weather conditions are favorable to successful planting and establishment of lawns and meadows.
 - a. Do not spread seed when wind velocity exceeds five miles per hour.
 - b. Do not plant when drought, or excessive moisture, or other unsatisfactory conditions prevail.
 - 3. Herbicides, chemicals and insecticides shall not be used on areas bordering wetlands.

- B. Scheduling:
1. Coordinate planting with specified extended service periods to provide required service from date of Substantial Completion. Do not begin lawn and meadow planting until water, acceptable for use and adequate in supply, is available on-Site and can be successfully transported to the areas of Work. Coordinate provision of adequate and acceptable water supply with Project Schedule.
 2. Do not proceed with installation of loam until all subgrade utility services have been installed, are operating successfully and have been approved by ENGINEER.
- C. Pre-installation Conference:
1. Prior to commencement of lawn and meadow planting and associated Work, CONTRACTOR shall schedule and meet at the Site with the landscape installer, the installers of other Work in and around lawn and meadow areas that follows the lawn and meadow Work, and ENGINEER and other representatives directly concerned with performance of the Work. Review foreseeable methods and procedures related to the lawn and meadow Work, including the following:
 - a. Review Project requirements and the Contract Documents.
 - b. Review required submittals, both completed and yet to be completed.
 - c. Review availability of water and methods of delivery.
 - d. Review status of below-grade work and required access during lawn and meadow planting and establishment.
 - e. Review Project Schedule and availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
 - f. Review environmental conditions, other Project conditions, and procedures for coping with unfavorable conditions.
 - g. Review procedures required for protection of lawns and meadows during the remainder of the construction period.
 - h. Review required inspection, testing, and certifying procedures.
 2. Record the discussions of the Pre-installation Conference and the decisions and agreements or disagreements reached, and furnish a copy of the record to each party attending.
 3. Record all revisions or changes agreed upon, reasons therefor, and parties agreeing or disagreeing with them.
 4. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

1.8 WARRANTY

- A. General Warranty: The special warranties specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents.
- B. Special Warranties: Warranty lawns and meadows through the specified extended service period.

1.9 EXTENDED SERVICE

A. Extended Lawn Service:

1. Begin extended service immediately after each lawn area is acceptably established. Provide extended service for not less than the following periods:
2. Seeded Lawns: Sixty days from date after lawn areas are acceptably established.
 - a. When full service period has not elapsed before end of planting season, or if lawn is not acceptably established, continue service during next planting season.
3. Service lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
4. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources. Keep newly germinated plants uniformly moist to a depth of 4-inches, applied at a minimum rate of 1-inch per week, or greater as required to maintain minimum moisture depth specified. Provide and maintain watering gages and soil moisture probes until end of maintenance period.
 - a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - b. After plants have their first true leaves and grasses show mature blades, watering shall be performed to provide moisture to a depth of 6-inches, and not performed again until top 1-inch of loam has dried.
5. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass-leaf height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowing to maintain the following grass height:
 - a. Mow grass 1-1/2 to 2-inches high.
6. Lawn Fertilization: Apply fertilizer after initial mowing and when grass is dry.
 - a. Use fertilizer that will provide actual nitrogen of at least one pound for each 1000 square feet of lawn area.
7. After seed has passed its expected germination period, reseed all areas and parts of areas that fail to show a uniform stand of grass. Reseed repeatedly until all areas are covered with grass.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil:

1. All soil accepted as topsoil, whether obtained from on-Site or off-Site sources, shall comply with specified topsoil analysis.
2. Provide fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth; free of any admixture of subsoil, clods of hard earth, plants or roots, sticks, stones larger than 1-inch in diameter, or other extraneous material harmful to plant growth, in compliance with ASTM D 5268. Provide topsoil with the following analysis:
 - a. 3/4-inch mesh: 100 percent passing.
 - b. No. 4-sieve: 90 to 100 percent passing.
 - c. No. 200-sieve: 0 to 10 percent passing.
 - d. Clay content of material passing No. 200-sieve not greater than 60 percent, as determined by hydrometer tests.
 - e. pH-adjusted with ferrous sulphate or ground limestone to provide pH 5.5 to pH 7.0 at time of installation of lawns, grass and meadow areas, unless particular species of grass or wildflower stand requires a different pH to meet its growing needs.
 - f. Electrical conductivity of a 1:2 soil-water suspension shall not exceed 1.0 milliohm per centimeter and with less than 200 parts per million of extractable aluminum.
 - g. Cation Exchange Capacity: 5, minimum.
 - h. Organic content not less than five percent, as determined by ignition loss of oven-dried samples passing No. 10-sieve (Muffle Furnace Temperature: 110 plus or minus five degrees C for eight hours).
 - i. Free of pests and pest larvae.
3. Topsoil Source: Reuse surface soil stockpiled on-Site, where possible. Verify suitability of stockpiled surface soil to produce topsoil, as specified. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
 - a. Supplement acceptable on-Site soil with manufactured topsoil from off-Site sources, when quantities available on-Site are insufficient to complete the Work.

B. Lawn Grass Seed:

1. Lawn Grass Seed Mixture: Provide fresh, clean, new-crop seed complying with the tolerance for purity and germination established by AOSA. Provide seed of the grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, specified.
2. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 80 percent pure seed, and not more than 0.25 percent weed seed by weight:
 - a. Full Sun: Kentucky Bluegrass (*Poa pratensis*), a minimum of three cultivars.

- b. Sun and Partial Shade: Proportioned by weight as follows:
 - 1) 50 percent Kentucky Bluegrass (*Poa pratensis*).
 - 2) 30 percent Chewings Red Fescue (*Festuca rubra* variety).
 - 3) 10 percent Perennial Ryegrass (*Lolium perenne*).
 - 4) 10 percent Redtop (*Agrostis alba*).
 - c. Shade: Proportioned by weight as follows:
 - 1) 50 percent Chewings Red Fescue (*Festuca rubra* variety).
 - 2) 35 percent Rough Bluegrass (*Poa trivialis*).
 - 3) 15 percent Redtop (*Agrostis alba*).
- C. Erosion-Control Materials:
 - 1. Erosion-Control Blankets: 100 percent biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended 6-inches long steel wire staples.
 - 2. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 pounds per cubic yard, with 50 to 65 percent open area. Include manufacturer's recommended 6-inches long steel wire staples.
- D. Accessories:
 - 1. Provide herbicides, chemicals and insecticides as needed for disease, fungus or pest control. All herbicides, chemicals and insecticides shall be bear approval labels indicating they are approved by the United States Department of Agriculture for the intended uses and application rates.
 - 2. Post Emergent Crab Grass and Plantain Chemical: Provide recommended post emergent crab grass and plantain control throughout the maintenance period to ensure germinated and established lawns free of crab grass and other undesirable grasses and forbs.
- E. Water: Acceptable for lawn and meadow application and containing no material harmful to plant growth and establishment.
- F. Loam Mixes
 - 1. Follow recommendations of soil-testing laboratory for modifying on-Site soil and manufactured soil, for use as topsoil.
 - 2. On-Site soil and manufactured soil that has been provided with all inorganic soil amendments and fertilizers recommended by soil-testing laboratory, and acceptable for use as topsoil, shall be mixed with an additional organic soil amendment mix in a ratio of two parts topsoil to one part organic soil amendment mix, by volume.
 - 3. Prepare soil amendment mix by combining 40 percent compost, 40 percent peat moss, ten percent wood derivatives, five percent well-rotted manure and five percent grit aggregate, by volume.
 - 4. Loam: Thoroughly blend topsoil with organic soil amendment mix and use as planting media for all lawn and meadow Work.

PART 3 - EXECUTION

3.1 INSPECTION

- A. CONTRACTOR shall examine the areas and conditions under which lawn and meadow Work is to be performed, and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 PREPARATION

- A. Thoroughly blend and mix loam before spreading. Incorporate fertilizers, and ground limestone or acidulant, after spreading, as specified, and at rates recommended by soil-testing laboratory.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding overspray.
- C. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- D. Perform percolation tests on existing subgrade and placed fills prior to fine grading.
 - 1. Perform percolation testing of subgrades and placed fills to determine whether or not the subgrade will drain properly. Perform percolation tests in accordance with the following procedure:
 - a. Dig a hole in the subgrade that is 4-inches in diameter and 12-inches deep.
 - b. Fill the hole with water and wait for the water to completely drain from the hole.
 - c. Immediately refill the hole with water and measure the rate of fall in the water level.
 - 2. In the event that water drains at a rate less than 1-inch in one hour, excavate soil to a minimum depth of 24-inches, and deeper, as necessary to break the compaction. Backfill, recompact and retest each area so prepared to confirm drainage rates exceed one inch in one hour.
 - 3. Perform minimum of one soil percolation test for every 10,000 square feet of lawn and meadow area.
- E. Excavate or fill subgrade, as required, to bring subgrade to elevations shown. Maintain all angles of repose. Confirm that subgrade is at proper elevations and that no further earthwork is required to bring the subgrade to proper elevations. Provide subgrade elevations that slope parallel to finished grade and towards subsurface drains shown.

- F. Remove all construction debris, trash, rubble and all extraneous materials from subgrade. In the event that fuels, oils, concrete washout or other material harmful to plant growth or germination have been spilled into the subgrade, excavate the subgrade sufficiently to remove all such harmful materials and fill with approved fill, compacted to the required subgrade compaction level.

3.3 FINE GRADING

- A. Immediately prior to dumping and spreading loam, clean subgrade of all stones greater than 2-inches and all other extraneous matter. Remove all such material from Site. Notify ENGINEER that subgrade has been cleaned, and obtain approval prior to spreading loam.
- B. Do not attempt to spread excessively wet, muddy or frozen loam. Do not spread loam more than five days before seeding or planting.
- C. Spread loam to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement.
 - 1. Spread approximately one-half the thickness of required loam depth. After spreading loam, rototill, disk or harrow loam and subgrade to bring top 2-inches of subgrade upward into loam layer, so that there is a transitional layer between loam and subgrade.
 - 2. Spread remainder of loam to required finish grades.
 - 3. Compact each lift sufficiently to reduce settling, but not enough to prevent the movement of water and feeder roots through loam. After compaction spread loam should offer firm, even resistance when a soil sampling tube is inserted.
 - 4. Phase the placement of the final lift so that wheeled vehicles do not have to travel over areas where final lifts are already in-place.
 - 5. Spread and compact to a smooth, uniform surface plane, to within plus or minus 1/2-inch of finish elevations. Roll and rake and remove all ridges, and fill depressions, as required. Remove all stones larger than 1-inch in any dimension and all sticks, roots, trash and other extraneous matter.
 - 6. Perform percolation tests as for subgrades, except limit depth of holes to 2/3 the depth of loam layer.
- D. Spread ground limestone or acidulant and fertilizer, as specified. Mix ground limestone with dry loam before spreading fertilizer and work lightly into the top 4-inches of loam by harrowing or tilling at least three days before applying commercial fertilizers.
- E. Grade planting areas to smooth, even surface with loose, uniformly fine texture. Remove all stones and extraneous material in excess of 1-inch diameter. Roll, rake and remove ridges and fill depressions, as required to meet finish grades.
- F. Moisten prepared areas before seeding, sodding, sprigging or plugging. Water thoroughly and allow surface moisture to dry before planting. Do not create a muddy loam condition.

- G. Prior to seeding or planting, restore loam to specified condition, if eroded or otherwise disturbed.

3.4 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
- B. Mix slurry with asphalt-emulsion tackifier.
- C. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry application at a minimum rate of 500-pounds per acre dry weight, but not less than the rate required to obtain specified seed-sowing rate so that the seed comes into direct contact with loam.
- D. Apply slurry cover coat of fiber mulch at a rate of 1000-pounds per acre.

3.5 RECONDITIONING EXISTING LAWNS AND MEADOWS

- A. Recondition existing lawn and meadow damaged by CONTRACTOR'S operations, including areas used for storage of materials or equipment and areas damaged by movement of vehicles. Recondition existing lawns and meadow areas where minor regrading is required.
- B. Recondition other existing lawn and meadow areas shown.
- C. Provide fertilizer, seed or sod and soil amendments, as specified for new lawn and meadow, and as required to provide satisfactorily reconditioned lawns and meadows. Provide new loam as required to fill low spots and meet new finish grades.
- D. Till stripped, bare, and compacted areas thoroughly to a depth of 12-inches.
- E. Remove diseased or unsatisfactory lawn and meadow areas; do not bury into soil. Remove topsoil containing extraneous materials resulting from CONTRACTOR'S operations including oil drippings, stone, gravel and other construction materials.
- F. In areas approved by ENGINEER, where substantial lawns and meadows remain (but are thin), mow, dethatch, core aerate and rake. Fill low spots, remove humps, cultivate soil, fertilize, and seed. Remove weeds before seeding or if extensive, apply selective chemical weed killers, as required. Apply a seedbed mulch, if required, to maintain moist condition.
- G. Water newly planted areas and keep moist until new lawns and meadows are established, as specified.

3.6 ACCEPTANCE CRITERIA FOR LAWNS AND MEADOWS

- A. Lawn and meadow Work will be considered acceptable when:
 - 1. Seeded Lawn: When a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 square feet and bare spots not exceeding 5-inches by 5-inches.

3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris, created by lawn and meadow Work, from paved areas. Clean wheels of vehicles before leaving Site to avoid tracking soil and loam onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout extended service period and remove when service period ends. Treat, repair or replace damaged lawns and meadows.
- C. Remove erosion-control measures after lawn and meadow extended service period ends.
- D. Take all precautions to ensure that hydroseed slurry is only placed on the areas designated. Completely clean any overspray, on areas not designated to receive slurry.

3.8 INSPECTION AND ACCEPTANCE

- A. Where lawns and meadows do not comply with specified acceptance criteria, reestablish lawns and meadows and continue extended service period until lawns and meadows comply with criteria for acceptance.

3.9 DEMONSTRATION

- A. Engage installer's Site supervisor to train and instruct OWNER'S personnel in the proper maintenance of lawns and meadows and procedures to be performed throughout the year for proper care and maintenance of lawn and meadows.
 - 1. Include instructions and training on reconditioning established lawns and meadow and sources of lawn and meadow materials.
 - 2. Schedule training with OWNER, through ENGINEER, with at least seven days' advance notice.
- B. Review Operation and Maintenance information and be sure all instructions are clearly understood by OWNER'S personnel and are supplemented with additional information, clarifications and instructions, as required.
- C. Provide minimum of two, nonconsecutive, full days on-Site training time during day shift normal working hours.

++ END OF SECTION ++

SECTION 32 93 10

LANDSCAPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contract includes a stipulated sum cash allowance for CONTRACTOR to employ and pay for an OWNER selected independent landscaper to provide landscaping provisions as determined by Owner at select Lift Station sites to be specified by Owner.

1.2 ALLOWANCES

- A. Cash Allowance – Owner Directed Landscaping: Included under provisions of Section 01 21 00, Allowances.
- B. Responsibilities:
 - 1. OWNER will provide CONTRACTOR information regarding selected landscaper and landscaping provisions.
 - 2. CONTRACTOR responsibilities associated with landscaping are outlined in Article 1.5 of this Section and are not included in the established Allowance.

1.3 QUALITY ASSURANCE

- A. Landscaper Qualifications:
 - 1. Owner will engage a single landscape installer skilled, trained and with successful and documented experience in the planting of plants and in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work.

1.4 SUBMITTALS

- A. Informational Submittals: Submit the following:
 - 1. Qualifications Statements: Upon CONTRACTOR's request, landscaper will submit the following:
 - a. Qualifications statement indicating experience and facilities for this type of Work.

1.5 CONTRACTOR'S COORDINATION WITH LANDSCAPER

- A. CONTRACTOR shall provide the following relative to OWNER-selected landscaper:
 - 1. Coordinate and schedule landscape Work with landscaper.
 - 2. Provide landscaper access to Owner designated Work Sites for landscaper to perform OWNER directed Landscaping Work.

3. Provide secure location at Owner designated Work Sites for landscaper to store materials and equipment.
4. Protect Site, including landscaping, from damage until Final Completion.
5. Provide proper documentation to OWNER, in accordance with requirements of Section 01 21 00, Allowances, when requesting payment for services furnished under the Owner Directed Landscaping Cash Allowance.

- B. CONTRACTOR shall pay for any additional Work requested of landscaper:
1. To repair areas of landscaping damaged by CONTRACTORS operations.
 2. That was not designated by OWNER to be performed.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 33 01 30.42

CLEANING OF WET WELLS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, tools, equipment and incidentals as shown, specified, and required to clean the wet wells for subsequent condition assessment and wet well rehabilitation work Specified in Section 33 01 30.81, Wet Well Rehabilitation and Section 33 01 30.82 Epoxy Lining of Concrete Wet Wells.
 - 2. The cleaning work required includes, but is not limited to, the following:
 - a. Cutting of roots and grease from existing wet wells.
 - b. Pressure washing of wet well walls, channel and bench prior to wet well rehabilitation and lining Work.
 - c. Disposal of waste and sediment.
 - d. Cleaning up as the project progresses and after the completion of all project activities.
 - e. All other work required for the complete and satisfactory cleaning of the wet wells.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the wet well rehabilitation and epoxy lining of concrete wet wells.
- C. Related Sections:
 - 1. Section 01 14 16, Coordination with Owner's Operations.
 - 2. Section 01 51 05, Temporary Utilities.
 - 3. Section 01 51 41, Temporary Pumping.
 - 4. Section 01 74 05, Cleaning.
 - 5. Section 33 01 30.81, Wet Well Rehabilitation.
 - 6. Section 33 01 30.82, Epoxy Lining of Concrete Wet Wells.

1.2 GENERAL PRECAUTIONS

- A. This Contract requires work in active sewers. Adhere to all federal, state and local requirements for safety in confined spaces.
- B. Take precautions to protect sewer mains, and wet wells from damage that might be inflicted by the improper selection of the cleaning process or improper use of the equipment.

1.3 SUBMITTALS

- A. Action Submittals: Submit for approval, the following:
 - 1. Product Data:
 - a. Wet well cleaning equipment, including performance data on pump, hose diameter and length, tank capacity, and intended nozzles to be employed.
- B. Informational Submittals: Submit for acceptance, the following:
 - 1. Special Procedure Submittals: Plan for disposal of debris and sediment removed from the wet wells.

1.2 SITE CONDITIONS

- A. Existing Conditions: This Work requires work in active Sewers. Adhere to all federal, state and local requirements for safety in confined spaces.

PART 2 - PRODUCTS

2.1 CLEANING EQUIPMENT

- A. The equipment shall include a high velocity washing hose for cleaning of the walls and floor of the wet well. The hose shall have an adjustable nozzle capable of producing flow from a fine spray to a solid stream. All controls shall be located so that the equipment can be operated above ground.

2.2 VACUUM EQUIPMENT

- A. Provide equipment capable of removing all sand, dirt, rocks, roots, and other debris from the wet well.

2.3 CLEANING WATER

- A. Provide all water required for the cleaning of wet wells either by truck or by an agreement with a potable water distribution system entity in accordance with Section 01 51 05, Temporary Utilities.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Plug incoming sewer lines entering wet well to allow for cleaning and subsequent wet well rehabilitation and lining Work, comply with requirements of Section 01 14 16, Coordination with Owner's Operations, regarding shutdowns.
 - 1. Provided temporary pumping systems to maintain collection system in service while pumping stations and wet wells are out of service to perform Work. Comply with requirements of Sections 01 51 41, Temporary Pumping, and Section 01 14 16 Coordination with Owner's Operations.

3.2 WET WELL CLEANING

- A. Wash the wall, bench, flow channel and rungs of the wet well to remove accumulated debris, sediment, grit, etc.
- B. Thoroughly clean each wet well in order to permit the required wet well rehabilitation methods to be completed. Particular emphasis shall be afforded to the removal of accumulated grease, roots, sand, rocks, sludge and other debris so that the wet well is sufficiently clean enough for rehabilitation to take place.

3.3 DEBRIS REMOVAL

- A. Remove all bricks, rocks, debris, sludge, dirt, sand, grease, roots, and other materials from the cleaned wet well.
- B. Waste and debris cleaned from the wet well shall be removed by pumps or other means. Under no circumstances shall sewage or solids be dumped onto the ground surface, street, stream, ditches, catch basins, or storm drains. All solids and semi-solids shall be placed in a watertight container so that no spillage or leakage will occur, covered to minimize odors, and disposed by the CONTRACTOR. The CONTRACTOR is responsible for all operations and costs associated with removal, transportation, and disposal of debris collected during the cleaning operations.

3.4 DISPOSAL

- A. Comply with requirements of Section 01 74 05, Cleaning, regarding waste disposal.

3.5 FIELD QUALITY CONTROL

- A. Acceptance of wet well cleaning shall be made upon the successful visual inspection documenting that all required debris, roots, and grease are removed to the satisfaction of the ENGINEER. If inspection shows debris, solids, sand, grease or grit remaining in the wet well, re-clean the wet well at no additional compensation.

++ END OF SECTION ++

SECTION 33 01 30.81

WET WELL REHABILITATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Provide all labor, materials, equipment, and incidentals necessary to rehabilitate pre-cast concrete wet wells as described herein.
 - 2. The extent and type of Work is shown on the Drawings. Field verify all Work locations and all other adjacent and relevant utility locations or other pertinent site conditions prior to any work.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the lining of concrete wet wells.
- C. Related Sections:
 - 1. Section 01 22 13, Measurement and Payment.
 - 2. Section 01 665 00, Product Delivery Requirements.
 - 3. Section 01 66 00, Product Storage and Handling Requirements.
 - 4. Section 02 41 00, Demolition.
 - 5. Section 03 00 05, Concrete.
 - 6. Section 33 01 30.42, Cleaning of Wet Wells.
 - 7. Section 33 01 30.82, Lining of Concrete Wet Wells.
 - 8. Section 33 05 13, Manholes and Structures.
 - 9. Section 33 32 00 Packaged Sanitary Drain Lift Stations.

1.2 REFERENCES

- A. Reference Standards: Standards referenced in this Section are:
 - 1. ASTM: American Society for Testing and Materials:
 - a. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
 - b. ASTM C293 - Test Method for Flexural Strength of Concrete (Center point loading).
 - c. ASTM C 469 - Standard Test Method for Static Modulus of Elasticity and Poisson's Ration of Concrete in Compression.
 - d. ASTM C 596 - Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
 - e. ASTM C 666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - f. ASTM C580 – Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.

- g. ASTM C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems used with Concrete by Slant Shear.
- h. ASTM D7234 – Test method for Pull-off Adhesion Strength of Coatings on Concrete using Portable Pull-off Adhesion Testers.

1.3 ADDITIONAL WORK ITEMS

- A. Item A5 – Wet Well Rehabilitation: Provide under the provisions of Section 01 22 13, Measurement and Payment.
 - 1. Item A5.1 Repair of Concrete Cracks.
 - 2. Item A5.2 - Concrete Surface Repair, Using Cementitious Resurfacer.
 - 3. Item A5.3 - Concrete Surface Repair, Using Repair Mortar.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturers:
 - a. Shall have a minimum of five years experience producing substantially similar products for projects of similar scope.
 - b. Provide minimum of five project histories including: names, dates, addresses and telephone numbers of contacts persons for projects of similar scope which were completed a minimum of three years ago.
 - 2. Applicators:
 - a. All wet well rehabilitation subcontractor's site personnel shall be trained in the hazards associated with confined space entry. All personnel entering a confined space shall be certified for confined space entry.
 - b. Injection Grouting Subcontractor:
 - 1) Completed injection grouting for least 20 sanitary sewer structures using the proposed products and application methods.
 - c. All Work must be supervised by a foreman responsible for rehabilitating a minimum of 15 sanitary sewer structures using the proposed manufacturer's products and processes.

1.5 SUBMITTALS

- A. Action Submittals: Submit for approval, the following:
 - 1. Product Data: Information for all products proposed for use, including manufacturer's brochures, technical data, specifications, and other applicable data.
- B. Informational Submittals: Submit for acceptance, the following:
 - 1. Manufacturer's Instructions: Manufacturer's recommended procedures for installing materials proposed for use.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements: Comply with requirements of Section 01 65 00, Product Delivery Requirements, and the following:
 - 1. Clearly mark on containers manufacturer's name and label, name or title of material, manufacturer's stock number, and date of manufacture.
 - 2. Handle materials carefully to prevent inclusion of foreign matter.
 - 3. Do not open containers or mix components until necessary preparatory Work has been completed and application Work is to start immediately.
- B. Storage and Handling Requirements: Comply with Requirements of Section 01 66 00, Product Storage and Handling Requirements, and the following:
 - 1. Store only approved materials at the Site.
 - 2. Store materials in sealed original manufacturer's containers.
 - a. Keep containers clean and undamaged.
 - 3. Store materials in a protected area out of direct sunlight.
 - 4. Adhere to manufacturer's published storage temperature and shelf life recommendations.
 - a. Protect materials from freezing.

1.7 SITE CONDITIONS

- B. Existing Conditions: This Work requires work in active Sewers. Adhere to all federal, state and local requirements for safety in confined spaces.
- C. Environmental Conditions:
 - 1. Refer to specific product data sheets for minimum surface temperature requirements.
 - a. Surface temperatures shall be a minimum of 5 degrees F above dew point and in a rising mode.
 - 2. Provide for proper ventilation using explosion proof equipment.

1.8 SEQUENCING

- A. Perform applicable wet well rehabilitation work for a given wet well in the following generalized sequence:
 - 1. Perform demolition work shown or indicated on the Drawings in accordance with the requirements of Section 02 41 00, Demolition.
 - 2. Clean wet well in accordance with Section 33 01 30.42, Cleaning of Wet Wells. Provide cleaning as necessary between the subsequent steps to maintain wet well in proper condition to receive next phase of Work.
 - 3. Condition Assessment of wet well by Owner's representative to identify areas of wet well in need of additional rehabilitation by means of injection grouting or cementitious surface repairs.
 - 4. Complete any additional demolition required for wet well rehabilitation work identified during condition assessment.

5. Plug pipes indicated to be plugged and place concrete fill in base of wet well as appropriate for directing flow towards the inverts of the proposed pumps. Follow Section 03 00 05, Concrete.
6. Place new top riser wall section of wet well and new wet well top slabs in accordance with the requirements of Sections: 33 32 00, Packaged Sanitary Drain Lift Stations, 03 00 05, Concrete, and 33 05 13, Manholes and Structures.
7. Stop active leaks and repair cracks identified during the condition assessment by injection grouting.
8. Repair concrete surfaces identified during the conditions assessment.
9. Prepare manhole to receive appropriate lining system as specified in Section 33 01 30.82, Lining of Concrete Wet Wells.

PART 2 - PRODUCTS

2.1 INJECTION GROUT MATERIALS

- A. Hydrophobic Polyurethane Grout:
 1. Shall be used for stopping leaks and sealing cracks identified by ENGINEER.
 2. Shall be low viscosity, moisture activated, MDI-based, hydrophobic polyurethane grout, able to withstand wet/dry cycles, injected as a single component to fill voids and stop active or potential water leaks and stabilize soils.
 3. Products and Manufacturer: Provide one of the following:
 - a. AV-275 SoilGrout as manufactured by Avanti International.
 - b. AV-278 Low Vis Hydro as manufactured by Avanti International.
 - c. Or equal.
- B. Hydrophilic Polyurethane Grout:
 1. Shall be used for stopping leaks and sealing cracks identified by ENGINEER.
 2. Shall be a single component, moisture activated, MDI/TDI blended, hydrophilic polyurethane injection resin designed for sealing active water leaks in large cracks or joints in concrete structures.
 3. Products and Manufacturer: Provide one of the following:
 - a. AV-202 MultiGrout as manufactured by Avanti International.
 - b. Or equal.

2.2 CONCRETE SURFACE REPAIR MATERIALS

- A. Cementitious Resurfacer:
 1. Shall be used for patching and filling voids in concrete surfaces up to 1/2" thickness and to smooth substrate in degraded areas identified by ENGINEER.
 2. Shall be water based, three component, epoxy modified, cementitious resurfacing product containing: Portland cement, hydrophobic thixotropes, fiber-reinforcements, graded silica sand and other abrasion resistant aggregates.

3. It shall have the following minimum physical properties:
 - a. Compressive Strength (ASTM D7234): 750 psi, 28 days
 - b. Compressive Strength (ASTM C109) 5,500 psi, 28 days
 - c. Bond Strength (ASTM C 882): 2,804 psi, 28 days
 - d. Flexural Strength (ASTM C580): 1,270 psi, 28 days
 - e. Splitting Tensile Strength (ASTM C496): 600 psi, 28 days
 - f. Shrinkage (ASTM C596): 0.014 %, 28 days
4. Products and Manufacturer: Provide one of the following:
 - a. Duraplate 2300, Epoxy Modified Cementitious Resurfacer as manufactured by Sherwin-Williams Company.
 - b. Or equal.

B. Cementitious Repair Mortar:

1. Shall be used for patching and filling voids in concrete surfaces greater than 1/2-inch and up to 2-inch thickness and to smooth substrate in degraded areas identified by ENGINEER.
2. Shall be microsilica mortar product containing: Portland cement, graded silica sand, fibers and silica fume.
3. It shall have the following minimum physical properties:
 - a. Compressive Strength (ASTM C109) 10,400 psi, 28 days
 - b. Bond Strength (ASTM C882): 1,695 psi, 28 days
 - c. Flexural Strength (ASTM C293): 1,695 psi, 28 days
 - d. Tensile Strength (ASTM C496): 750 psi, 28 days
 - e. Shrinkage (ASTM C596): 0.000 %, 28 days
 - f. Modulus of Elasticity (ASTM C469): 4,533,333 psi
 - g. Freeze Thaw (ASTM C666): No effect, 100 cycles
4. Products and Manufacturer: Provide one of the following:
 - a. CENTEC Silatec MSM as manufactured by A.W. Cook Cement Products.
 - b. Or equal.

PART 3 - EXECUTION

3.1 PREPARATION

A. Demolition:

1. Perform demolition work shown or indicated on the Drawings in accordance with the requirements of Section 02 41 00, Demolition.
2. Perform additional demolition work required in preparation for wet well rehabilitation work identified by the Condition Assessment.
 - a. Remove by chipping, abrasive blasting, or hydro blasting all laitance, foreign materials, and unsound concrete from the entire area to be repaired. Perform additional surface preparation, if any recommended by repair product manufacturer.

- B. Cleaning:
 - 1. Clean wet well in accordance with Section 33 01 30.42, Cleaning of Wet Wells.
 - 2. Provide cleaning as necessary between the subsequent steps to maintain wet well in proper condition to receive next phase of Work.
- C. Inspection: ENGINEER will provide Condition Assessment of wet well to identify areas of wet well in need of injection grouting or cementitious surface repairs.
- D. Wetting Procedure: Where repair product manufacturer recommends saturated surface dry conditions, perform the following:
 - 1. Continuously apply water for at least four hours to surface being repaired. Where large surface areas are to be repaired, use fog-spray nozzles, mounted on stands, in sufficient number so that entire surface to be repaired is contacted by fog spray cloud.
 - 2. Prevent concrete from drying until after repair is completed. RE-wet surfaces not yet repaired using water sprays at least daily: should more than four days elapse without re-wetting surfaces not yet repaired, repeat original saturating procedure.
 - 3. Remove standing water in areas to be repaired before placing repair material, provide means to remove excess water from structure.

3.2 WET WELL BASE AND TOP

- A. Plug pipes indicated to be plugged and place concrete fill in base of wet well as appropriate for directing flow towards the inverts of the proposed pumps. Follow Section 03 00 05, Concrete.
- B. Place new top riser wall section of wet well and new wet well top slabs in accordance with the requirements of Sections: 33 32 00, Packaged Sanitary Drain Lift Stations, 03 00 05, Concrete, and 33 05 13, Manholes and Structures.

3.3 GENERAL PRODUCT MIXING REQUIREMENTS

- A. Mix and handle the materials, including their component parts in accordance with manufacturer's recommendations and to minimize hazard to personnel.
- B. Provide appropriate protective measures to ensure that the components and the chemicals produced in mixing are under the control of the CONTRACTOR at all times and are not available to unauthorized personnel or others.

3.4 CONCRETE SURFACE REPAIRS

- A. ENGINEER shall verify required demolition in areas identified for surface repairs has been completed and that remaining concrete is sound and suitable for receiving designated repair products.
 - 1. ENGINEER shall indicate which locations, if any, require which surface repair products.
- B. Completely fill the ENGINEER identified repair areas with the ENGINEER indicated repair materials and cure materials, in accordance with material manufacturer's instructions and the Contract Documents.

3.5 CRACK INJECTION GROUTING

- A. ENGINEER will identify cracks requiring injection grouting repair. Injection grouting Subcontractor shall determine which of the specified grouting products should be used, at each location in order to stop active leakage in the structures.
- B. Install and cure injection grout materials in accordance with manufacturer's requirements.
- C. After injecting and curing, verify that injected material penetrated the crack adequately and that there is no visible leakage through the crack. If crack continues to leak, re-inject crack at no additional cost to OWNER until structure is watertight.
- D. If proper penetration of crack cannot be achieved, submit to ENGINEER a proposed alternative approach for modifying the specified injection procedure to properly seal the crack.

3.6 INSPECTION AND REPAIR

- A. After wet well rehabilitation has been completed, visually inspect the wet well in the presence of ENGINEER. Check for cleanliness, soundness of repairs, and for elimination of leakage. Repair all defects identified by the ENGINEER.

3.7 CLEANUP

- A. Remove all debris from the wet well.
- B. If debris from CONTRACTOR'S work has entered the sewer pipe, clean the affected pipe(s) to the satisfaction of the ENGINEER and at no additional cost to the OWNER.

+ + END OF SECTION + +

SECTION 33 01 30.82

LINING OF CONCRETE WET WELLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Provide all labor, materials, equipment, power, water, and incidentals necessary for installation of a lining system to make wet wells corrosive resistant.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the lining of concrete wet wells.

C. Related Sections:

1. Section 33 01 30.42, Cleaning of Wet Wells.
2. Section 33 01 30.81, Wet Well Rehabilitation.
3. Section 33 32 00, Packaged Sanitary Drain Lift Stations.

1.2 REFERENCES

A. Reference Standards: Standards referenced in this Section are:

1. ASTM (American Society for Testing and Materials):
 - a. ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
 - b. ASTM D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
 - c. ASTM D638, Standard Test Method for Tensile Properties of Plastics.
 - d. ASTM D695, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - e. ASTM D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - f. ASTM D1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - g. ASTM D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - h. ASTM D1653, Standard Test Methods for Water Vapor Transmission of Organic Coating Films.
 - i. ASTM D2240, Standard Test Method for Rubber Property – Durometer Hardness.
 - j. ASTM D2794, Standard Test Method for Resistance of Organic Coating to the Effects of Rapid Deformation (Impact).

- k. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
- l. ASTM D4338, Standard Test Method for Flexibility Determination of Supported Adhesive Films by Mandrel Bend.
- m. ASTM D4585, Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.
- n. ASTM D7234, Standard Test Method for Pull-Off adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
- o. ASTM G210, Standard Practice for Operating the Severe Wastewater Analysis Testing Apparatus.

1.3 QUALITY ASSURANCE

A. Qualifications:

- 1. Manufacturers:
 - a. Shall have a minimum of five years experience producing substantially similar products for projects of similar scope.
 - 1) Provide minimum of five project histories including: names, dates, addresses and telephone numbers of contacts persons for projects of similar scope which were completed a minimum of three years ago.
 - b. Shall have in existence, for a minimum of three years, a nationally organized program for training and technically supporting “Approved Contractors”.
 - 1) Submit manufacturer’s representative name, address and telephone number who will be available to provide information and guidance on the proper use of the products.
- 2. Applicators:
 - a. Coatings application subcontractor, foreman, and applicators shall be licensed and certified by the manufacturer of the coating system proposed for use in performing the Work and have successfully completed applications using the specified materials on projects of similar size and scope.
 - 1) Provide three references including: names, dates, addresses and telephone numbers of contacts persons.
 - 2) Provide written approval of the coating system manufacturer.
 - 3) All wet well coating work shall be supervised by a foreman responsible for rehabilitating a minimum of 10 sanitary sewer structures using the proposed manufacturer’s lining system.
 - 4) All wet well coating work shall be performed by applicators having applied the proposed coating system to a minimum of 10 sanitary sewer structures.
 - b. All coatings application subcontractor’s site personnel shall be trained in the hazards associated with confined space entry. All personnel entering a confined space shall be certified for confined space entry.

- B. Component Supply and Compatibility:
 - 1. Obtain all materials included in this Section regardless of the component manufacturer from a single coatings system manufacturer.
 - 2. Require the coatings system manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 3. All components shall be approved for the specified service conditions and shall be integrated into the overall equipment assembly by the lining system manufacturer.
- C. Preinstallation Conference:
 - 1. The CONTRACTOR, the coatings application subcontractor, and the lining system manufacturer's representative shall meet on site with the OWNER's representative. Particular emphasis shall be placed on these specifications, safety, weather conditions, surface preparation, material application, and inspection.
 - 2. The CONTRACTOR shall submit to the OWNER's representative any revisions or changes agreed upon, reasons thereof, and parties agreeing or disagreeing with them.

1.4 SUBMITTALS

- A. Action Submittals: Submit for approval, the following:
 - 1. Product Data:
 - a. Technical data sheet on each product used including application, cure time and surface preparation procedures.
 - b. Material Safety Data Sheet (MSDS) for each product used.
 - c. Copies of independent testing performed on the coating product indicating the product meets the requirements as specified herein.
 - d. Submit proof of acceptability of proposed application techniques by coating manufacturer selected.
 - e. Copies of CONTRACTOR's proposed protection procedures in each area of the Work explaining methods of protecting adjacent surfaces from splatter, for confining application procedures in a manner that allows other work adjacent to surface preparation and coating Work to proceed safely and without interruption, and for maintaining acceptable application, curing, and environmental conditions during and after painting systems application.
 - f. Identify maximum exposure times allowable for each coating system component before next coat can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.
 - g. Information on curing times and environmental conditions that affect curing time of each coating system component and proposed methods for accommodating variations in curing time. Identify this information for each coating system in the Work.

- h. Specification for spray equipment with cross-reference to coating manufacturer's recommended equipment requirements.
- B. Informational Submittals: Submit for acceptance, the following:
 - 1. Qualifications Data: as specified in Paragraph 1.3.A. for:
 - a. Manufacturer.
 - b. Application contractor.
 - c. Foreman.
 - d. Applicators.
 - 2. Certificates:
 - a. Certificate from lining products manufacturer stating that materials meet or exceed Contract Documents requirements.
 - b. CONTRACTOR shall provide notarized statement verifying that lining system is compatible with surfaces specified.
 - 1) All lining systems components shall be reviewed by an authorized technical representative of lining products manufacturer for use as a compatible system.
 - 2) Verify that lining system is acceptable for exposures specified and that lining product manufacturer is in agreement that selected system is proper, compatible, and not in conflict with manufacturer's recommended specifications.
 - 3) Show by copy of transmittal form that a copy of letter has been transmitted to lining system applicator.
 - 3. Field Quality Control Submittals.
 - a. Test and Evaluation Reports: Daily Quality Control Reports.
 - b. Manufacturer Reports.
 - 4. Special Procedure Submittals:
 - a. Testing Plans, Procedures and Testing Limitations:
 - 1) Quality Plan: including the Inspection Test Plan.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery and Acceptance Requirements:
 - 1. Deliver products to the Site in manufacturer's original, unopened containers bearing manufacturer's name and label and the following information:
 - a. Product name.
 - b. Product description (generic product classification).
 - c. Manufacturer's lot number.
 - d. Color.
- B. Storage and Handling Requirements:
 - 1. Store materials in sealed original manufacturer's containers.
 - 2. Store materials in protected area out of direct sunlight.
 - 3. Keep containers clean and undamaged.
 - 4. Adhere to manufacturer's published storage temperatures and shelf life recommendations. Protect all materials from freezing.
 - 5. Protective coating materials are to be handled according to their material safety data sheets.

1.6 SITE CONDITIONS

- A. Existing Conditions: This Work requires work in active Sewers. Adhere to all federal, state and local requirements for safety in confined spaces.
- B. Environmental Requirements:
 - 1. Comply with coatings manufacturer's specific product data sheets regarding minimum surface temperature requirements. Surface temperatures shall be at least 5 degrees F above dew point and in a rising mode.
 - 2. Provide for proper ventilation using explosion proof equipment. Allow to operate during the complete cure cycle of the coating.

1.7 SEQUENCING

- A. All Work specified in Sections 33 01 30.42, Cleaning of Wet Wells, 33 01 30.81, Wet Well Rehabilitation, and removal and replacement of wet well top riser section, bench concrete fill and top slab work specified in Section 33 32 00, Packaged Sanitary Drain Utility Lift Stations, shall be complete in each wet well before commencing the work of this Section within said wet well.

PART 2 - PRODUCTS

2.1 LINING SYSTEM

- A. System Description: The corrosion protective lining system shall consist of a 100 percent, high-build, glass flake reinforced, amine cured epoxy or a multi-layer, polyurea lining system designed for the protection of concrete in highly corrosive hydrogen sulfide environments.

2.2 LINING MATERIALS

- A. Epoxy Lining System:
 - 1. Primer (Optional):
 - a. Shall be a minimum 69-percent volume solids, two-component, polyamido-amine epoxy.
 - b. Shall be applied in a single layer to a nominal dry-film thickness of 2.0-6.0 mils prior to the application of an epoxy lining.
 - c. Products and Manufacturer: Provide one of the following products:
 - 1) Macropoxy 5500LT as manufactured by Sherwin-Williams Company.
 - 2) Or equal.
 - 2. Corrosion Protection Coating:
 - a. Shall be 100-percent solids, high-build, high strength, reinforced epoxy.
 - b. Shall be applied to a nominal dry-film thickness of 80.0-125.0 dry mils.
 - c. Shall have the following minimum physical properties:
 - 1) Adhesion – Concrete (ASTM D7234): Concrete Failure
 - 2) Abrasion Resistance (ASTM D4060)
 - 1,000 g, 1000 cycles, CS-17 Wheel: Less than 120 mg loss

- 3) Compressive Strength (ASTM D695) 10,000 psi
- 4) Elongation (ASTM D638): 2%
- 5) Flexural Modulus (ASTM D790): 12,000 psi
- 6) Hardness, Shore D (ASTM D2240): 75
- 7) Impact Resistance (ASTM D2794): 80 in. lbs
- 8) Tensile Strength (ASTM D638): 7,300 psi
- 9) Water Vapor Transmission (ASTM D1653): 0/gms/m2 (24 hrs)
- 10) Humidity Resistance (ASTM D4585): Pass
- 11) Severe Wastewater Analysis Test (ASTM G210): Pass
- d. Products and Manufacturers: Provide one of the following:
 - 1) DuraPlate 6000 Epoxy as manufactured by Sherwin-Williams Company.
 - 2) Or equal.

B. Polyurea Lining System:

- 1. Polyurea Adhesion Layer:
 - a. Shall be applied as a single, monolithic layer to a nominal dry-film thickness of 50 mils prior to the application of a Closed Cell Foam Surfacer layer.
 - b. It shall have the following minimum physical properties:
 - 1) Hardness (ASTM D2240) D 48
 - 2) Tensile strength (ASTM D412): 3315 psi
 - 3) 100% Modulus (ASTM D412): 1668 psi
 - 4) 200% Modulus (ASTM D412): 1960 psi
 - 5) 300% Modulus (ASTM D412): 2650 psi
 - 6) Tear resistance/DIE-C (ASTM D624): 417 pli
 - 7) Ultimate elongation (ASTM D412): 395 %
 - 8) Taber Abrasion, mg loss CS17 (ASTM D4060): 15 mg loss
 - 9) Flexibility, 1/8" mandrel (ASTM D4338) Pass
 - c. Products and Manufacturer: Provide one of the following:
 - 1) OBIC Armor 1000, Aromatic Polyurea as manufactured by OBIC, LLC.
 - 2) Or equal.
- 2. Closed Cell Foam Surfacer Layer:
 - a. Shall be used for filling voids in concrete surfaces and to smooth substrate prior to application of Final Polyurea Armor Layer.
 - b. Shall be applied at a moderate speed and repeated until the foam rise covers voids. Apply to a nominal thickness of 400 mils.
 - c. It shall have the following minimum physical properties:
 - 1) Density (ASTM D1622) 6-8 pcf
 - 2) Compressive Strength 1" (ASTM D1621): 130-180 psi
 - 3) Closed Cell Content: > 94%
 - 4) Water Absorption: < 0.03 lbs/sqft
 - 5) Maximum Service Temp: 180 deg
 - 6) Viscosity (A side) @ 72 deg F: 675 cps
 - 7) Viscosity (B side) @ 72 deg F: 200 cps

- d. Products and Manufacturer: Provide one of the following:
 - 1) OBIC Guard 1306, Polyurethane Surface Material as manufactured by OBIC, LLC.
 - 2) Or equal.
- 3. Final Polyurea Armor Layer:
 - a. Shall be 100-percent solids, no volatile organic compound (VOC), moisture tolerant, elastomeric polyurea.
 - b. Shall be applied as a single, monolithic layer to a nominal dry-film thickness of 50 mils.
 - c. Shall have the following minimum physical properties:

1) Hardness (ASTM D2240):	D 48
2) Tensile strength (ASTM D412):	3315 psi
3) 100% Modulus (ASTM D412):	1668 psi
4) 200% Modulus (ASTM D412):	1960 psi
5) 300% Modulus (ASTM D412):	2650 psi
6) Tear resistance/DIE-C (ASTM D624):	417 pli
7) Ultimate elongation (ASTM D412):	395 %
8) Taber Abrasion, mg loss CS17 (ASTM D4060):	15 mg loss
9) Flexibility, 1/8" mandrel (ASTM D4338)	Pass
10) Severe Wastewater Analysis Test (ASTM G210):	Pass
 - d. Products and Manufacturer: Provide one of the following:
 - 1) OBIC Armor 1000, Aromatic Polyurea as manufactured by OBIC, LLC.
 - 2) Or equal.

2.3 INSTRUMENTS

- A. Environmental Measurements: Provide a digital dew point meter to monitor air temperature, dew point and relative humidity; and an infrared surface temperature meter for measuring the substrate surface temperatures.
- B. Quality Control Testing: Provide one wet film thickness gauge and one holiday detector to detect holidays or holes in the coating.
 - 1. Products and Manufacturers: Provide the following:
 - a. Holiday detector shall be Elcometer 266 as manufactured by Elcometer, or equal.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verification of Conditions:

1. CONTRACTOR and its applicator shall examine the areas and conditions under which the lining of wet wells is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the lining of wet wells. Do not proceed with the lining of wet wells until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
 - a. Surface temperatures shall be a minimum of five degrees F above the dew point and in a rising mode for the application of lining materials.
 - b. Minimum substrate surface profile of CSP#3.

3.2 PREPARATION

- A. Condition Assessment: ENGINEER will provide Condition Assessment of wet well to identify structures to receive lining system. CONTRACTOR shall only proceed with wet well lining in wet wells identified to receive such in ENGINEER's Condition Assessment.
- B. All active water leaks within the wet well shall be stopped and identified concrete surface defects within the wet well shall be repaired in accordance with the requirements of Section 33 01 30.81, Wet Well Rehabilitation, prior to commencing lining work with the wet well.
- C. Substrate Preparation: Comply with coating manufacturer's published recommendations for products, surface condition, and surface preparation.
- D. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation, and lining Work.

3.3 APPLICATION

- A. Mix and prepare lining products in strict accordance with manufacturer's product data sheets.
- B. Apply coating materials in accordance with manufacturer's printed data sheet instructions:
 1. Refer to specific product data sheets for minimum surface temperature requirements. Surface temperatures shall be a minimum of 5 degrees F above dew point and in a rising mode.
 2. Provide for proper ventilation using explosion proof equipment. Allow to operate during the complete cure cycle of the coating.

- C. Notify ENGINEER after completing each coat of lining materials. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by ENGINEER, proceed with succeeding coat. Perform testing using testing instruments specified in Article 2.3 of this Section.
 - 1. ENGINEER will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
 - 2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.
- D. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit testing results to ENGINEER.

3.4 FIELD QUALITY CONTROL

- A. Preparation:
 - 1. Contractor shall submit a Quality Plan (QP) including: and Inspection Test Plan (ITP) indicating all quality control testing that will be performed during the lining application, including the acceptance criteria and a sample of their quality control reporting documents prior to lining applicator mobilizing to Site.
 - 2. Provide a trained quality control inspector who will carry out or supervise all quality control inspections.
 - 3. Record all quality control operations on a daily QC report that will be delivered to the ENGINEER at intervals agreed upon at pre-installation meeting.
- B. Site Tests: Minimum quality control testing shall include but not be limited to:
 - 1. Environmental Measurements: Document air temperature, substrate temperature, dew point and relative humidity a minimum of four times per day using a digital dew point monitor, and infrared surface temperature meter.
 - 2. Surface Cleanliness: Prior to surface preparation, test to ensure surface cleanliness. The surface shall be free of oil , grease, and other contaminants that may impeded adhesion of the lining as per ASTM D4258.
 - 3. Substrate Surface Profile: Visual inspection per SSPC-SP13/NACE 6.
 - 4. Wet Film Thickness Testing: Testing using notched wet film thickness gages as per ASTM D4414.
 - 5. Dry Film Thickness Testing: separate dry film thickness testing for all coats as per SSPC – PA9.
 - 6. Holiday Testing: Verify a pinhole free surface in accordance with ASTM D4787 or NACE SP0188.

C. Manufacturer's Services:

1. Furnish services of a qualified factory-trained serviceman to visit the Site at the request of the ENGINEER to check the surface preparation before lining products are applied, and/or the finished application and cure of the lining products.
2. Serviceman shall make not less than two visits for a period of not less than one 8-hour day each to the Site as requested by ENGINEER.
3. All costs including expenses for travel, lodging, meals and incidentals and cost of travel time, for visits to Site shall be included in the Contract Price.

3.5 CLEANING

- A. During progress of the Work, remove from Site all discarded lining products, rubbish, cans, and rags at end of each workday.

+ + END OF SECTION + +

SECTION 33 05 05

BURIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections.
 - b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
 - c. Work on or affecting existing buried piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
 - e. Supports, restraints, and thrust blocks.
 - f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
 - g. Field quality control, including testing.
 - h. Cleaning.
 - i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Process Integration.

C. Related Sections:

1. Section 09 91 00, Painting.
2. Section 31 23 05, Excavation and Fill.
3. Section 40 05 05, Exposed Piping Installation.
4. Section 40 05 08, Valves and Miscellaneous Piping Appurtenances.
5. Section 40 05 19, Ductile Iron Process Pipe.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
 - 2. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
 - 3. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.
 - 4. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 5. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
 - 6. AWWA M23, PVC Pipe - Design and Installation.
 - 7. AWWA M41, Ductile-Iron Pipe and Fittings.
 - 8. AWWA M55, PE Pipe - Design and Installation.
 - 9. American Concrete Pipe Association, Concrete Pipe Handbook.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including.
 - a. OWNER.
 - 2. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Laying schedules for concrete pipe and piping with restrained joints.
 - b. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.
 - 2. Product Data:
 - a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
 - 3. Testing Procedures:
 - a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER's approval prior to commencing testing.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
 - 2. Field Quality Control Submittals:
 - a. Results of each specified field quality control test.

- C. Closeout Submittals: Submit the following:
1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
 - b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
 - c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
 - d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Conform to requirements of Section 01 65 00, Product Delivery Requirements and the following:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
 2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.
 3. Storage: Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements and the following:
 4. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
 5. Pipe and fittings other than PVC and CPVC may be stored outdoors without cover. Cover PVC and CPVC pipe and fittings stored outdoors.
- B. Handling: Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements and the following:
1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
 2. Avoid unnecessary handling of pipe.
 3. Keep pipe interiors free from dirt and foreign matter.
 4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 40, Process Integration.
- B. General:
 - 1. Pipe Markings:
 - a. Factory-mark each length of pipe and each fitting with designation conforming to those on approved laying schedules.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.
- C. Polyethylene Encasement:
 - 1. Polyethylene may be supplied in tubes or sheets.
 - 2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

2.2 BURIED PIPING IDENTIFICATION

- A. Polyethylene Underground Warning Tape for Metallic Pipelines:
 - 1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
 - 2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
 - 3. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products
 - c. Marking Services, Inc.
 - d. Or equal.
- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
 - 1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
 - 2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet.

3. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.
4. Manufacturer: Provide products of one of the following:
 - a. Brady Corporation
 - b. Seton Identification Products
 - c. Marking Services, Inc.
 - d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.
3. ENGINEER will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify ENGINEER in advance of excavating, bedding, pipe laying, and backfilling operations.
4. Minimum cover over buried piping shall be four feet, unless otherwise shown or approved by ENGINEER.
5. Earthwork is specified in Section 31 23 05, Excavation and Fill.
6. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted in accordance with Section 31 23 05, Excavation and Fill .

B. Separation of Sewers and Potable Water Piping:

1. Horizontal Separation:
 - a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.
 - b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.
 - c. Exception:
 - 1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2. Vertical Separation:
 - a. Provide minimum vertical distance of 18 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.
 - b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.
 - c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.
 - d. Exceptions:
 - 1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.
 - 2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

C. Plugs:

1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.
3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.
4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.

D. Bedding Pipe: Bed pipe as specified and in accordance with Section 31 23 05, Excavation and Fill.

1. Trench excavation and backfill, and bedding materials shall conform to Section 31 23 05, Excavation and Fill, as applicable.
2. Where ENGINEER deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with 31 23 05, Excavation and Fill. Payment for additional excavation and providing granular material will be made under the unit price payment items in the Contract.
3. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.
4. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.

5. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
6. Do not lay pipe until ENGINEER approves bedding condition.
7. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

E. Laying Pipe:

1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
 - b. Thermoplastic and HDPE Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA, M55.
2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
3. Slope piping uniformly between elevations shown.
4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by ENGINEER.
7. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
8. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.
9. For PVC and CPVC piping with solvent welded joints, 2.5-inch diameter and smaller, and copper tubing, snake piping in trench to compensate for thermal expansion and contraction.
10. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
11. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
12. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
13. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.

14. Touch up protective coatings in manner satisfactory to ENGINEER prior to backfilling.
15. Notify ENGINEER in advance of backfilling operations.
16. On steep slopes, take measures acceptable to ENGINEER to prevent movement of pipe during installation.
17. Thrust Restraint: Where required, provide thrust restraint conforming to Article 3.3 of this Section.
18. Exercise care to avoid flotation when installing pipe in cast-in-place concrete, and in locations with high groundwater.

F. Polyethylene Encasement:

1. Provide polyethylene encasement for ductile iron piping to prevent contact between pipe and surrounding bedding material and backfill.
2. Polyethylene encasement installation shall be in accordance with ANSI/AWWA C105.

G. Jointing Pipe:

1. Ductile Iron Mechanical Joint Pipe:
 - a. Immediately before making joint, wipe clean the socket, plain end, and adjacent areas. Taper cut ends and file off sharp edges to provide smooth surface.
 - b. Lubricate plain ends and gasket with soapy water or manufacturer's recommended pipe lubricant, in accordance with ANSI/AWWA C111, just prior to slipping gasket onto plain end of the joint assembly.
 - c. Place gland on plain end with lip extension toward the plain end, followed by gasket with narrow edge of gasket toward plain end.
 - d. Insert plain end of pipe into socket and press gasket firmly and evenly into gasket recess. Keep joint straight during assembly.
 - e. Push gland toward socket and center gland around pipe with gland lip against gasket.
 - f. Insert bolts and hand-tighten nuts.
 - g. If deflection is required, make deflection after joint assembly and prior to tightening bolts. Alternately tighten bolts approximately 180 degrees apart to seat gasket evenly. Bolt torque shall be as follows:

Pipe Diameter (inches)	Bolt Diameter (inches)	Range of Torque (ft-lbs)
3	5/8	45 to 60
4 to 24	3/4	75 to 90
30 to 36	1	100 to 120
42 to 48	1.25	120 to 150

- h. Bolts and nuts, except those of stainless steel, shall be coated with two coats, minimum dry film thickness of eight mils each, of high build solids epoxy or bituminous coating manufactured by Tnemec, or equal.
- i. Restrained mechanical joints shall be in accordance with Section 40 05 19, Ductile Iron Process Pipe.

2. Thermoplastic Pipe Joints:
 - a. Solvent Cement Welded Joints:
 - 1) Bevel pipe ends and remove all burrs before making joints. Clean pipe and fittings thoroughly. Do not attempt to make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
 - 2) Use solvent cement supplied or recommended by pipe manufacturer.
 - 3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
 - 4) Take appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit water when flushing or filling pipelines to prevent compression of gases within pipes.
3. Mechanical Coupling Joints:
 - a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings specified in Section 40 05 08, Valves and Miscellaneous Piping Appurtenances.
 - b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with wire brush to remove foreign matter.
 - c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
4. HDPE Pipe Joints:
 - a. Butt Fusion Welded Joints:
 - 1) Install joints in accordance with manufacturer's instructions using hydraulic butt fusion machine or manual machine equipped with torque wrench. Equipment shall be able to achieve and maintain heating tool temperature range of 400 to 450 degrees F and an interface pressure of 60 to 90 psi.
 - 2) Clean interior and exterior of pipe and fitting ends with clean, dry, lint-free cloth.
 - 3) Align ends to be joined in the fusion machine without forcing ends into alignment. Adjust alignment as necessary and tighten clamps to prevent slippage.
 - 4) Place facing tool between ends to be joined and face them to provide clean, smooth, parallel mating surface. If stops are present, face ends down to the stops. Remove all shavings after facing without touching ends.

- 5) Re-check alignment of ends and check for slippage against fusion pressure. There shall be no detectable gaps between ends. Align outside diameters.
- 6) Heating tool shall maintain pipe manufacture's recommended temperature range. Place the tool between ends to be joined. Move ends against heating tool to achieve full contact. Hold ends against heating tool without force until the following melt bead size is formed:

Pipe Diameter (inches)	Required Melt Bead Size (inches)
2 to 4	1/8 to 3/16
4 to 12	3/16 to 1/4
12 to 24	1/4 to 7/16
24 to 54	7/16 to 9/16

- 7) Upon forming proper melt bead size, quickly separate ends and remove heating tool. Quickly inspect melted ends and bring ends together applying joining force recommended by manufacturer, using 60 to 90 psi interfacial pressure to form double bead rolled over surface of pipe on both ends.
- 8) Hold joining force against ends until joint is cool to the touch. Cooling period shall be 30 to 90 seconds per inch of pipe diameter. Heavier wall thicknesses may require longer cooling times as recommended by pipe manufacturer.
- 9) Upon completing joint, inspect to verify double bead has been formed on both sides, uniformly rounded and consistent in size all around joint. Remove faulty joints and re-joint.

H. Backfilling:

1. Conform to applicable requirements of Section 31 23 05, Excavation and Fill .
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:

1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

- B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
 - 1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
 - 2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
 - 3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
 - 4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

- A. Provide thrust restraint on pressure piping systems.
- B. Thrust restraint may be accomplished by using restrained pipe joints, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this Section.
- C. Restrained Pipe Joints:
 - 1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
 - a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 05 19, Ductile Iron Process Pipe; lugs and tie rods; or other joint restraint systems approved by ENGINEER.
 - b. Thermoplastic and HDPE Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of ENGINEER.

3.4 WORK AFFECTING EXISTING PIPING

- A. Location of Existing Underground Facilities:
 - 1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
 - 2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.
- B. Taking Existing Pipelines and Underground Facilities Out of Service:
 - 1. Conform to Section 01 14 16, Coordination with Owner's Operations.
 - 2. Do not take pipelines or Underground Facilities out of service unless specifically listed in Section 01 14 16, Coordination with Owner's Operations, or approved by ENGINEER.
 - 3. Notify ENGINEER in writing prior to taking pipeline or Underground Facilities out of service. Shutdown notification shall be provided in advance of the shutdown in accordance with the General Conditions and Section 01 14 16, Coordination with Owner's Operations.

- C. Work on Existing Pipelines or Underground Facilities:
1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
 2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
 3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
 4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations, Section 01 73 29, Cutting and Patching, and Section 01 73 24, Connections to Existing Facilities.

3.5 FIELD QUALITY CONTROL

- A. General:
1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
 2. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
 3. Conduct all tests in presence of ENGINEER.
 4. Remove or protect pipeline-mounted devices that could be damaged by testing.
 5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
 6. CONTRACTOR shall provide fluid required for hydrostatic testing and shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.
 7. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
 8. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of OWNER. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.
- B. Test Schedule:
1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
 - a. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
 - b. Test natural gas piping and prove free of leaks in strict accordance with the requirements of the International Fuel Gas Code.

2. Test Pressure:
 - a. Use test pressures listed in Buried Piping Schedule in this Section.
 - b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.
- C. Hydrostatic Testing:
 1. Preparation for Testing:
 - a. For thermoplastic pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
 - b. For other piping follow procedures described in ANSI/AWWA Manual M9, except that minimum wetting period required immediately prior to testing for asbestos cement pipe shall be 24 hours rather than the 48 hours prescribed for concrete pipe. Wetting period is not required for pipe that is not cement mortar-lined.
 - c. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
 2. Test Procedure:
 - a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
 - b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
 - c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
 - d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 - e. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
 - f. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.
 - g. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.
 3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
 - a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

- b. Rates based on formula or table in ANSI/AWWA Manual M41:
 - 1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
 - a) Bell and spigot and push-on joints.
 - b) Mechanical joints.
 - c) Bolted sleeve type couplings.
 - d) Grooved and shouldered couplings.

3.6 CLEANING

- A. Cleaning, General: Clean pipe systems as follows:
 - 1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service.
 - 2. Plastic Pipe: Clean vacuum and liquid piping with a detergent and water and thoroughly rinse to remove all detergent, after which cleaning ball or swab shall be drawn through pipe.

3.7 SCHEDULES

- A. Schedules listed below, following the “End of Section” designation, are part of this Specification section.
 - 1. Table 33 05 05-A, Buried Piping Schedule.

+ + END OF SECTION + +

TABLE 33 05 05-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test
FM	6 to 16	DI	CL	PEW	CL, 53	RMJ	HYD (100)
SP	2	PVC	--	--	SCH. 80	SW	HYD (60)
NG	2-1/2	HDPE	--	--	DR 11	BFW	IFGC

Service Abbreviations

Service	Abbrev	Service	Abbrev.	Service	Abbrev.
Force Main	FM	Sump Pump	SP	Natural Gas	NG

Material Abbreviations

Material	Abbrev	Material	Abbrev.	Material	Abbrev.
Ductile Iron	DI	High Density Polyethylene	HDPE	Polyvinyl Chloride	PVC

Lining/Coating Abbreviations

Lining	Abbrev	Coating	Abbrev.
Cement Mortar Lined	CL	Polyethylene Wrapped	PEW

Abbreviations

Joint Type	Abbrev	Joint Type	Abbrev.	Joint Type	Abbrev.
Butt Fusion Weld	BFW	Solvent Weld	SW	Restrained Mech. Joint	RMJ

Test Abbreviations

Test	Abbrev	Test	Abbrev
Hydrostatic Test (test pressure in psig)	HYD ()	International Fuel Gas Code	IFGC

SECTION 33 05 13

MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all precast, and cast-in-place manholes and structures.
- B. General:
 - 1. Manholes and structures shall conform in shape, size, dimensions, material, and other respects to the details shown or as directed by ENGINEER.
 - 2. Concrete for cast-in-place structures and for fill and pipe supports in precast manholes and structures shall be Class "A" and shall conform to the requirements specified under Section 03 00 05, Concrete.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 40 05 31, Thermoplastic Process Pipe.
 - 3. Section 33 32 00, Packaged Sanitary Drain Lift Stations

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Society for Testing and Materials, (ASTM).
 - a. ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections.
 - 2. American Water Works Association, (AWWA).
 - a. AWWA C302, Reinforced Concrete Pressure Pipe, Non-cylinder Type, for Water and Other Liquids.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Submit drawings showing design and construction details of all precast concrete and cast-in-place manholes and structures, including details of joints between the manhole bases and riser sections and stubs or openings for the connections.
 - 2. Product Data:
 - a. Copies of manufacturer's catalog information for the products proposed for use, specifications, load tables, dimension diagrams, anchor details, and installation instructions.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE MANHOLES AND STRUCTURES

- A. Precast manholes and structures shall conform to the details shown. Provide cast-in-place concrete bases where shown.
- B. Except where otherwise specified precast manhole components shall consist of reinforced concrete pipe sections especially designed for manhole construction and manufactured in accordance with ASTM C478, except as modified herein.
- C. Precast, reinforced concrete manhole bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing or other imperfections.
- D. Joints between manhole components shall be the tongue and groove type employing a single, continuous rubber O-ring gasket and shall conform to AWWA C302. The circumferential and longitudinal steel reinforcement shall extend into the bell and spigot ends of the joint without breaking the continuity of the steel. Joints between the base sections, riser sections and top slabs of manholes 72-inches in diameter and less shall be rubber and concrete joints. Joints for manhole components greater than 72-inches in diameter shall be provided with steel bell and spigot rings.
- E. All precast manhole components shall be of approved design and of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30 percent in roadways and 15 percent in rights-of-way for impact. Manhole bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall not be less than 5-inches. Concrete top slabs shall not be less than 8-inches thick.
- F. Lifting holes, if used in manhole components, shall be tapered, and no more than two shall be cast in each section. Tapered, solid rubber plugs shall be furnished to seal the lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.
- G. The point of intersection (P.I.) of the sewer pipe centerlines shall be marked with 1/4-inch diameter steel pin firmly enclosed in the floor of each manhole base and protruding approximately 1-inch above the finished floor of the base.
- H. Mark date of manufacture and name or trademark of manufacturer on inside of barrel.
- I. The barrel of the manhole shall be constructed of various lengths of riser pipe manufactured in increments of one foot to provide the correct height with the fewest joints.

2.2 MISCELLANEOUS EQUIPMENT AND APPURTENANCES

- A. Manhole Steps:
 - 1. 1/2 inch diameter steel reinforcing rod continuous through entire length of legs and tread, encapsulated in a copolymer polypropylene plastic.
 - 2. Provide steps with notched tread ridge and retainer lugs on each side of tread ridge.

- B. Board Insulation System:
 - 1. System Manufacturers:
 - a. The Dow Chemical Co.,
 - b. Or equal.
 - 2. Insulation: Dow Thermax Light Duty.
 - a. Type: Polyisocyanurate, closed cell, glass fiber-reinforced.
 - b. Board Thickness: 2 inches unless indicated otherwise on Drawings.
 - c. Board Edges: Square.
 - d. Facing: Factory-applied 1.25 mil embossed aluminum foil sheet on backside, and 1.25 mil embossed white acrylic-coated aluminum sheet on front.
 - e. Thermal Resistance: Aged R-value of 6.5 per inch, at 75 degrees F mean temperature.
 - f. Water Vapor Permeance: Less than 0.03 perms; ASTM E96.
 - g. Compressive Strength: 25 pounds per square inch, minimum; ASTM D1621.
 - h. Flexural Strength: 55 pounds per square inch, minimum; ASTM C203.
 - 3. Adhesive: Construction adhesive as instructed by system manufacturer for application to concrete.
 - 4. Sealant: Polyurethane or silicone as instructed by system manufacturer.
 - 5. Sheet Anchors: Dow PVC Interlock Joint Closures:
 - a. PVC male and female "T" strips for securing insulation to substrate.
 - 6. Edge Anchors: Dow PVC J Channels:
 - a. PVC J channel for covering exposed board edges.

- C. Floor Door and Drain Piping:
 - 1. Floor Door:
 - a. Manufacturers:
 - 1) Babcock-Davis Hatchways, Series B-FGA-H.
 - 2) The Bilco Company, Type J-AL and H-20.
 - 3) Halliday Products, Inc., Series H1W.
 - 4) Milcor Limited Partnership, Model GD.
 - 5) Or equal.
 - b. Load Rating: 300 pounds per square foot.
 - c. Frame:
 - 1) Material: Extruded aluminum sections shaped to serve as a continuous drainage gutter with a 1-1/2 inch drain coupling.
 - 2) Anchors: Continuous anchor flange.
 - 3) Apply manufacturer's standard protective coating to surfaces of frame that will be in contact with concrete.

- d. Cover:
 - 1) Material: 1/4 inch mill finish aluminum diamond plate, reinforced with stiffening ribs.
 - 2) Hinges: Stainless steel; butt type with compression spring operators enclosed in telescopic tubes.
 - 3) Hold Open Arm: Stainless steel; automatically locks door at 90 degree position; provide vinyl grip handle to release door for closing.
 - 4) Lock: Stainless steel; slam type with fixed handle inside and removable key wrench outside.
- e. Hardware and Fasteners: Type 316 stainless steel.
- f. Accessories: Provide one key wrench for each door supplied.
- g. Insulation: 1 inch thick glass fiber; fully covered with 18 gage aluminum sheet.
- h. Drain Piping: Shall be PVC and shall conform to the requirements specified under Section 40 05 31, Thermoplastic Process Pipe and Section 40 05 05, Exposed Piping Installation.
- 2. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".

D. Anchors:

- 1. General Requirements:
 - a. Type 316 stainless steel for anchors exposed to weather, in contact with aluminum components, or in submerged conditions.
 - b. Zinc-plated, ASTM B633, for anchors in all other conditions.
- 2. Expansion Anchors:
 - a. Manufacturers:
 - 1) Hilti Corporation, Kwik Bolt II.
 - 2) ITW Ramset/Red Head, Trubolt Wedge Anchor.
 - 3) The Powers Rawl Company, Inc., Power-Stud.
 - 4) Or equal.
 - b. Comply with Federal Specification FF-S-325 Group II, Type 4, Class I.
 - c. Minimum Embedment: 4 inches, unless otherwise indicated.

E. Sump Pump and Discharge Piping (Station P):

- 1. Sump Pump:
 - a. Manufacturers: Barnes/Crane, Model BP314ABR; or equal.
 - b. Performance: 30 gpm at 15 feet lift; 1/3 HP, 115 volt, single-phase, 60 Hz.
 - c. Type: Completely submersible vertical centrifugal.
 - d. Casing: Cast iron pump body and oil-filled motor chamber.
 - e. Impeller: Bronze; closed, stainless steel shaft.
 - f. Bearings: Ball bearings.

- g. Accessories: Oil-resistant 8 foot cord and plug with 3-prong connector for connection to electric wiring system including grounding connector.
 - h. Controls: Integral diaphragm switch type level controls.
 - i. Power Circuit: Provide 120V receptacle mounted in the meter vault for powering the 120V sump pump. 120V, 15A circuit to be provided by the station P pump house control panel. See 2.3(J)(3)(E) of Section 33 32 00 Packaged Sanitary Drain Lift Stations for requirements.
- 2. Discharge Piping: Shall be PVC and shall conform to the requirements specified under Section 40 05 31, Thermoplastic Process Pipe and Section 40 05 05, Exposed Piping Installation.
 - 3. Ball Valves for Plastic Pipe:
 - a. Manufacturers: Chemtrol, Model Tru-Bloc, or equal.
 - b. For use with CPVC or PVC plastic pipe, true union design, pressure rating equal to or exceeding ratings of installed pipe, capable of holding line pressure with coupling removed on either side of valve without linking, lever operated, Teflon ball seats, and Viton stem and body seals.
 - 4. Plastic Ball Check Valves:
 - a. Manufacturers: Chemtrol, Model True Union Ball Check Valves, or equal.
 - b. 150 psi water working pressure, constructed of materials for use with PVC or CPVC plastic pipe, double-union design which permits removal of the valve with no disruption of connecting piping, operate in either horizontal or vertical position, socket or threaded ends.
- F. Stilling Tube:
- 1. Follow Section 40 05 31 Thermoplastic Process Pipe.
- G. Suction Bypass Piping:
- 1. Station N wet well shall incorporate piping to permit emergency suction pumping from the lift station wet well.
 - 2. The suction bypass piping shall be 6-inch diameter ductile iron in accordance with Section 40 05 19. Ductile Iron Process Pipe, and terminate on top of the wet well with a 6-inch diameter male quick connect coupling with dust cap and 6-inch long security chain, in accordance with Section 40 05 08, Valves and Miscellaneous Piping Appurtenances.
- H. Posts:
- 1. Provide Schedule 80 galvanized steel pipe filled with concrete as shown on the Drawings. Paint as required in accordance with Section 09 91 00, Painting. Unless otherwise shown or specified, finish-paint bollard "Safety Yellow."

- I. High Water Level Alarm Float Switch
 1. Provide a high level alarm float switch at the locations listed below to trigger an alarm for water in the respective vault. High water alarm wiring shall be routed and connected to the respective pump station control panel for monitoring. See Section 33 32 00 - Packaged Sanitary Drain Lift Stations for float switch requirements.
 - a. Station N Valve Vault
 - b. Station P meter vault

PART 3 - EXECUTION

3.1 PRECAST MANHOLE SECTIONS

- A. Set sections vertical with steps and sections in true alignment. The base of the bell or groove end at joints between components shall be buttered with 1:2 cement-sand mortar to provide a uniform bearing between components. All joints shall be sealed with cement mortar inside and out and troweled smooth to the contour of the wall surface. Raised or rough joint finishes will not be accepted.
- B. Install sections, joints and gaskets in accordance with manufacturers recommendations.
- C. Lifting holes shall be sealed tight with a solid rubber plug driven into the hole from the outside of the barrel and the remaining void filled with 1 to 2 cement-sand mortar.

3.2 CAST-IN-PLACE CONCRETE

- A. Comply with the requirements specified under Section 03 00 05, Concrete.

3.3 BOARD INSULATION SYSTEM

- A. Verify that substrate, adjacent materials, and insulation boards are dry and substrate is ready to receive insulation.
- B. Verify substrate surface is flat, free of honeycomb, fins, irregularities, materials, or substances that may impede proper installation.
- C. Insulation: Install as instructed by manufacturer and the following.
 1. Install to ceiling before walls.
 2. Mechanically attach female PVC "T" strips to substrate.
 3. Apply continuous beads of adhesive to substrate, between strips.
 4. Install boards with white side exposed.
 5. Apply sealant to face of board adjacent to joint. Install male PVC "T" strips into female strips securing boards in place. Remove excess sealant.
 6. Install J channel at all exposed edges of boards, including top edges of wall boards.
 7. Apply sealant to joints at board cut-outs where J channel cannot be used.

3.4 PIPING

- A. Comply with the requirements of Section 40 05 05, Exposed Piping Installation.

3.5 MISCELLANEOUS PRODUCTS

- A. Install miscellaneous products in accordance with Contract Drawings and manufacturer's instructions.

3.6 GRADING AT MANHOLES AND STRUCTURES

- A. All manholes and structures in unpaved areas shall be built, as shown or directed by the ENGINEER, to an elevation higher than the original ground. The ground surface shall be graded to drain away from the manhole. Fill shall be placed around manholes to the level of the upper rim of the manhole frame, and the surface evenly graded on a 1 to 5 slope to the existing surrounding ground, unless otherwise shown or directed by the ENGINEER. The slope shall be covered with 4-inches of topsoil, seeded and maintained until a satisfactory growth of grass is obtained.
- B. Manholes and structures in paved areas shall be constructed to meet the final surface grade.
- C. CONTRACTOR shall be solely responsible for the proper height of all manholes and structures necessary to reach the final grade at all locations. CONTRACTOR is cautioned that ENGINEER'S review of Shop Drawings for manhole components will be general in nature and CONTRACTOR shall provide an adequate supply of random length precast manhole riser sections to adjust any manhole to meet field conditions for final grading.

+ + END OF SECTION + +

SECTION 33 32 00

PACKAGED SANITARY DRAIN LIFT STATIONS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish and install (17) complete packaged submersible lift stations with above grade valve enclosures and packaged submersible Lift Station N and accessories, utilizing existing wet wells, as shown, specified and necessary for proper and complete performance.
- B. Coordination: Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before packaged lift station Work.
- C. Related Sections:
 - 1. Section 03 00 05, Concrete.
 - 2. Section 05 05 33, Anchor Systems.
 - 3. Section 09 91 00, Painting.
 - 4. Section 33 05 13, Manholes and Structures.
 - 5. Section 40 05 31, Thermoplastic Process Pipe.
 - 6. Section 40 05 19, Ductile Iron Process Pipe.
 - 7. Section 40 69 50, Packaged Smart Pump Control Systems.
 - 8. Section 43 21 39.13, Smart Submersible Pumps.

1.2 ALTERNATIVE PRODUCTS AND MANUFACTURERS

- A. Alternative A: Bidders must provide pricing (add or deduct) on the Bid Form for providing the Pumps specified in Section 43 21 39.13, Smart Submersible Pumps, and the packaged smart pump control systems specified in Section 40 69 50, Packaged Smart Pump Control Systems, in lieu of providing the pumps and pump system control panels specified in this Section, by Base Bid Sanitary Drain Lift Station supplier, Flygt, a Xylem Corporation Brand.
- B. Alternatives B and C: Bidders must provide pricing (add or deduct) on the Bid Form for providing the Packaged Sanitary Drain Lift Stations as specified in this Section by the following named alternative suppliers in lieu of providing the Packaged Sanitary Drain Lift Stations, by Base Bid supplier, Flygt, a Xylem Corporation Brand.
 - 1. Alternative B: Excel Fluid Group.
 - 2. Alternative C: The Gorman Rupp Company.

1.3 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/HI 1.3, Standard for Centrifugal Pumps for Design and Application.
 - 2. ANSI/HI 1.4, Standard for Centrifugal Pumps for Installation, Operation, and Maintenance.
 - 3. ANSI/HI 1.6, Centrifugal Pump Tests.
 - 4. ANSI/HI 9.1-9.5, Standard for Pumps – General Guidelines for Types, Definitions, Application, Sound Measurement, and Decontamination.
 - 5. ANSI/HI 9.6.2, Standard for Centrifugal and Vertical Pumps for Allowable Nozzle Loads.
 - 6. ANSI/HI 9.6.3, Standard for Centrifugal and Vertical Pumps for Allowable Operating Region.
 - 7. ANSI/HI 9.6.5, Centrifugal and Vertical Pumps for Condition Monitoring
 - 8. ANSI/HI 9.8, Pump Intake Design.
 - 9. ANSI/HI 11.6, Submersible Pump Tests.
 - 10. IEEE 85, Airborne Sound Measurements- Rotating Electrical Machinery.
 - 11. NEMA MG-1, Motors and Generators.

1.4 QUALITY ASSURANCE

- A. Supplier's Qualifications: Supplier shall have a minimum of five years experience producing substantially similar packaged equipment to that required for the Project and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.
- B. Component Supply and Compatibility:
 - 1. Obtain all products included in this Section, regardless of component manufacturer, from one packaged lift station supplier.
 - 2. Packaged lift station Supplier shall review and approve or prepare all Shop Drawings and submittals for all components provided under this Section.
 - 3. All components shall be suitable for specified service conditions and shall be integrated into overall assembly by the packaged lift station Supplier.
- C. Certifications
 - 1. Certification of Compliance:
 - a. Obtain certification of compliance with the Contract Documents from the packaged lift station supplier on supplier letterhead; certification by supplier's representatives is not acceptable.
 - b. Certification shall be worded as follows:

“*[Insert supplier's name]* proposes to supply equipment included in Section 33 32 00, Packaged Sanitary Drain Lift Stations for the Lenawee County Drain Commission, Lenawee County, Michigan, Rollin Woodstock, Sanitary Drain Lift Station Improvements. We have examined the Contract Documents and understand of the Project requirements insofar as they affect the proposed products. We certify that the products will operate satisfactorily under the conditions described in the Contract Documents and that the products meet the requirements of the Contract Documents:

[List exceptions, deviations or changes necessary or recommended to accommodate the proposed products.]

We further certify that the products to be furnished shall conform to the standards listed in Section 33 32 00, Packaged Sanitary Drain Lift Stations, of the Contract Documents.

[List exceptions, deviations or changes necessary to accommodate the proposed products.]

Authorized Signature & Title

Date

- c. Provide justification for exceptions, variations, deviations, or changes. ENGINEER will determine whether exceptions, deviations, and changes are acceptable. Exceptions, variations, deviations, and changes may result in rejection of products.
- d. Provide certification before submitting Shop Drawings. Shop Drawings will not be reviewed prior to receipt of certification.
- e. Acceptance of certification shall not relieve CONTRACTOR of responsibility for adequacy of all products.
- f. Submittal of certification shall not relieve CONTRACTOR and Supplier of requirement to comply with submittal procedures in the Contract Documents.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Packaged Lift Station Supplier shall provide Shop Drawings of complete lift stations showing existing wet well and all new proposed equipment installed, along with a specific lift station bill of materials. Generalized lift station drawings for groups of stations shall not be acceptable, a specific drawing shall be provided for each of the 18 stations.
- b. Shop Drawings of pump controls specified in this Section, including panel layout and wiring diagrams.

2. Product Data:

- a. Manufacturer's literature, illustrations, specifications, paint certification (if required) and engineering data including; dimensions, materials, size, weight, and part lists for all components in sufficient detail to allow an item-by-item comparison with the Contract Documents.
- b. Pump performance data and curves showing overall pump efficiencies, required net positive suction head (NPSH), allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed, and shut-off head. Curves shall range from minimum flow to shut-off head at for full speed and all speed curves specified. For variable speed units, curves shall have at least five speeds plotted between maximum and minimum rpm. Curves shall indicate Preferred Operating Region (POR) and Allowable Operating Region (AOR), as defined in ANSI/HI 9.6.3. Specify recommended ratio of available NPSH divided by required NPSH for water service.

- c. Motor Data: Furnish certified motor data sheet for previously tested, electrically duplicate motor to that specified, including the following:
 - 1) Speed-torque relationship.
 - 2) Efficiency at 1/2, 3/4, and full load.
 - 3) Power factor at 1/2, 3/4, and full load.
 - 4) Slip at full load.
 - 5) Running light, full load and locked rotor current.
 - 6) Temperature rises and results of dielectric tests.
 - 7) Bearing type and lubrication medium
 - 8) Insulation class and temperature ratings.
 - 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Provide pump Supplier's proposed shop testing plan, including complete list of testing facility limitations.
 - b. Provide proposed field testing plan.
- B. Informational Submittals:
 - 1. Certificates: Provide certificate of compliance as specified in this Section.
 - 2. Manufacturer Instructions:
 - a. Provide Supplier's instructions for handling and installing products.
 - b. Setting drawings, templates, and directions for installing anchor bolts and other anchorages.
 - 3. Source Quality Control Submittals:
 - a. Results of shop testing for complete pump and motor unit.
 - b. Location of nearest permanent service headquarters of pump manufacturer to the Site.
 - 4. Field Quality Control Submittals:
 - a. Results of field testing.
 - b. Submit a written report of the results of each visit to Site by pump manufacturer's service representative, including purpose and time of visit, tasks performed, and results obtained.
 - 5. Qualifications Statements:
 - a. Provide Supplier's qualifications as specified in Quality Assurance article of this specification.
- C. Closeout Submittals: Submit the following:
 - 1. Operation and Maintenance Manuals:
 - a. Submit complete operation and maintenance manuals, including shop and field test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Provide operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
 - 2. Warranty Documentation:
 - a. Manufacturer's Standard Warranty.
 - b. Special Warranty, if specified.

- D. Maintenance Material Submittals: Furnish the following:
1. Spare Parts for each Lift Station:
 - a. One spare fuse for each fuse in pump control panel.
 - b. One spare pilot light for each pilot light in pump control panel.
 - c. Two spare of any gaskets requiring replacement for routine inspection and maintenance, as applicable.
 2. Spare Parts for Project:
 - a. One mechanical seal for each pump model.
 - b. One complete set of all O-rings required for each pump model, in addition to the requirements of Item 1 c. above, as applicable.
 - c. One level transmitter-submersible pressure type with sufficient length of cable to replace longest provided for each model provided on the project. Provide 4 spares if all same model.
 - d. Four spare float switches with sufficient length of unspliced power cord sufficient to replace longest provided.
 - e. One breaker for each type and size installed.
 - f. One spare submersible pump for each of the 17 lift stations (excluding Station N). Where applicable, manufacturer shall overlap submersible pump selections to reduce quantity of spares on the shelf.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Prior to shipping, completely inspect products to assure that components are complete and comply with all requirements. Box or crate products as required to prevent damage during shipment. Protect machined surfaces and matching connections to prevent damage.
 2. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 3. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
 4. Comply with Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
1. Keep all products off ground using pallets, platforms, or other supports. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

1.7 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty on Packaged Sanitary Drain Lift Stations:
 - 1. Provide manufacturer's written non prorated warranty, running to the benefit of OWNER, agreeing to correct, at OWNER's option, remove, or replace materials or equipment specified in this Section and found to be defective for a period of five years after date of Substantial Completion. Replacement value of items regularly subject to wear in normal use, such as seals, bearings, impellers, rotors, and stator, may be prorated

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Packaged Lift Stations with above grade valve enclosures (All stations except Station N):
 - 1. Description: Complete lift station package including: submersible pumps and pump guide assemblies, piping including: base elbow, valves, and appurtenances; station enclosure consisting of: enclosure base with wet well access doors for mounting on wet wells, housing for valves and control components complete with heating/ventilation and lighting mounted to top of enclosure base at grade; and electrical and control components for an automatically controlled duplex or triplex submersible lift station, with pumps installed in wet well.
- B. Packaged Lift Station N:
 - 1. Description: submersible pumps and pump guide assemblies, piping including: base elbow and appurtenances; and electrical and control components for an automatically controlled triplex submersible lift station, with pumps installed in wet well.

C. Design and Performance Criteria: Each pump shall comply with the following:

LIFT STATION	PUMP QUANTITY	PUMP			MOTOR		
		FLOW (gpm)	TDH (ft)	EFF.	HP	VFD or Constant Speed (CS)	ELECTRICAL
A	2	200	42	44	5	CS	240v 3ph, 60Hz
B	2	320	54	58	10	CS	240v 3ph, 60Hz
C	2	500	30	64	7.5	VFD	240v 3ph, 60Hz
D	2	700	18	49	10	VFD	240v 3ph, 60Hz
E	3	600	28	61	7.5	VFD	240v 3ph, 60Hz
F	2	215	14	25	3	CS	240v 3ph, 60Hz
G	2	380	43	62	10	CS	240v 3ph, 60Hz
H	3	850	54	68	20	VFD	480v 3ph, 60Hz
I	2	740	53	66	20	CS	240v 3ph, 60Hz
J	2	640	63	66	25	CS w/ Soft Start	240v 3ph, 60Hz
K	2	520	31	60	7.5	CS	240v 3ph, 60Hz
L	2	380	67	63	15	VFD	240v 3ph, 60Hz
M	2	200	34	44	5	CS	240v 3ph, 60Hz
N	3	1800	77	70	75	VFD	480v 3ph, 60Hz
P	2	700	50	64	20	VFD	480v 3ph, 60Hz
Q	2	200	45	45	7.5	CS	240v 3ph, 60Hz
R	2	310	63	60	15	CS	240v 3ph, 60Hz
S	2	370	73	61	15	CS	240v 3ph, 60Hz

1. Pumps shall comply with ANSI/HI 1.3, ANSI/HI 9.6.3, and ANSI/HI 9.8.
2. Designed for both intermittent and continuous 24 hours per day operation, and for pumping unscreened raw domestic wastewater.
3. All openings, internal passages, and internal recirculation ports shall be large enough to permit the passage of a sphere 3 inches in diameter and any trash or stringy material which can pass through a residential collection system.
4. At all points on pump curve, pump horsepower requirements shall not exceed specified motor horsepower.
5. Listed motor horsepower are approximate. Contractor to verify the motor operating condition does not exceed the capacity of the electrical service and operational capability of the existing generator.

D. Suppliers:

1. Provide products supplied by one of the following:
 - a. Base Bid Manufacturer: Flygt, a Xylem Corporation Brand.
 - b. Excel Fluid Group.
 - c. The Gorman Rupp Company.

E. Submersible Pumps:

1. General:
 - a. Construct pumps for fluid service specified.
 - b. Construct pumps and appurtenances, including cable, for continuous submerged operation without leakage in specified depth of water.
2. Pump Body and Externals:
 - a. Stator casing, oil casing, sliding bracket, volute, and impeller shall be close-grained, gray cast iron, or as approved by Engineer.
 - b. Provide lifting eye or stainless steel lifting bail on each pump capable of bearing weight of pump during removal and installation.

- c. Securely fasten to each pump brass or stainless steel nameplate engraved with pump manufacturer's name, pump model and serial number, pump's rated flow and head, speed, and other pertinent data.
 - d. External Hardware: Bolts, nuts, and cap screws shall have hexagonal heads and be Type 316 stainless steel.
- 3. Impeller shall be enclosed vortex, single- or multi -vane, non-clog, dynamically balanced.
- 4. Shaft: Stainless steel.
 - a. Seals: Single-mechanical upper seal and single-mechanical lower seal.
- 5. Bearings: Anti-friction, grease- or oil-lubricated with minimum B-10 life of 100,000 hours.
- 6. Motors:
 - a. The motor shall be explosion proof, Class 1, Division 1 Group C & D.
 - b. Motor shall be stainless steel solid shaft, ball bearing type. Motor casing shall be watertight with moisture resistant Class H, 180 degrees C insulation. Voltage, phase, frequency, and horsepower shall be as specified in "Design and Performance Criteria" in this Section.
 - c. Motor shall be NEMA Design B, normal starting torque, normal slip, squirrel cage induction type, continuous duty.
 - d. Motor shall be capable of continuous operation in a submerged condition without damage. Pump and motor shall be capable of intermittent operation up to 10 starts per hour in submerged condition, without damage.
 - e. Motor shall be non-overloading for entire pump operating curve, shall have 1.15 service factor, and provide full rated horsepower with a voltage unbalance of three percent. Motors for use with variable frequency drives shall be inverter duty rated and have an insulation system constructed in compliance with or exceeding NEMA MG-1 Part 31.
 - f. Motor thrust bearings shall be capable of continuous thrust loads under all conditions of pump operation from zero head to shut-off. Anti-friction bearings shall be rated for B-10 life of 100,000 hours.
 - g. Motor Sensors:
 - 1) For supplemental motor protection, each pump motor shall be equipped with at least three thermal sensors embedded in stator windings and wired to the associated control panel.
 - 2) Provide leakage sensor in lower part of stator housing, wired to leads in motor's watertight terminal chamber.
 - 3) Motor sensor cables shall be provided with an electromagnetic compatibility filter in the motor terminal box.

- h. Power/Sensor Cables:
 - 1) Cables shall be the unspliced length required, suitable for submersible duty, and be so indicated by code or legend permanently applied to cable.
 - 2) AWG rated submersible pump cable sized accordingly to the motor supplied and the National Electric Code, not allowing a voltage drop of more than 5% from the panel to the motor. Cables shall have explosion proof mechanically compressed water and gas tight design, with quick connect ends to simplify installation and maintenance operations.
- i. Accessories: Provide the following for each pump unless otherwise specified.
 - 1) Anchor bolts and anchorage devices per Section 05 05 33, Anchor Systems.
 - 2) Discharge Elbow: Comply with requirements of Section 40 05 19, Ductile Iron Process Pipe.
 - 3) Pump Removal System:
 - a) Pumps shall automatically and positively mate and self seal with associated discharge piping when pump is lowered into place. Pumps shall be removable for inspection or service without requiring removal of bolts, nuts, or other fastenings.
 - b) Provide for each pump guide rails and brackets of extra-heavy Type 304 stainless steel.
 - c) Provide each pump with high-tensile strength, proof-tested stainless steel lifting cable. Cable shall be suitable for use with hoist. Provide sufficient length of cable for removing pump from wet well without requiring supplementary cords, cables, or chains. Connect cable to lifting eye or bail on pump, and provide loop or appropriate hardware at hoist-end of cable. Cable and hardware shall be sized to sustain all tensile stresses during lifting of pump.
 - d) For each pump, provide one suitable stainless steel hook or bracket on wall just below operating floor to which cable will be hooked when not used for hoisting.
 - e) Pump manufacturer shall provide items necessary for complete guide-in, pump removal system.

F. Piping and Piping Accessories:

- 1. Ductile iron pipe and fittings comply with requirements of Section 40 05 19, Ductile Iron Process Pipe.
- 2. Pipe Supports and Anchorage: Provide stainless steel pipe supports and anchorage to support and brace piping for all anticipated forces for all operating conditions.

3. Sleeve-type, Flexible Couplings:
 - a. Pressure and Service: Same as connected piping.
 - b. Products and Manufacturers: Provide products of one of the following:
 - 1) Style 253, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
 - 2) Style 441, by Smith Blair, Inc.
 - 3) Or equal.
 - c. Material: Ductile Iron.
 - d. Gaskets: Suitable for specified service, as recommended by manufacturer.
 - e. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
 - f. Harnessing
 - 1) Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 2) Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
 - 3) On plain-end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.
 - 4) Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.
4. Gage Kit:
 - a. Except for Station N, provide independently mounted from the discharge piping within the station enclosure, a 4 inch diameter glycerin-filled pressure gage, graduated to show full range of expected discharge pressures from pumps with 1 percent of full scale reading accuracy, complete with stainless steel hoses, fittings, diaphragm seals, shutoff valve on each discharge pipe connection and a three-way valve for monitoring the discharge pressure of either pump.
 - b. For Station N provide a 4 inch diameter glycerin-filled pressure gage graduated to show full range of expected discharge pressures from pumps with 1 percent of full scale reading accuracy, complete with stainless steel hoses, fittings, diaphragm seals, shutoff valve on each pump discharge pipe in the valve vault.

5. Discharge Bypass Piping:
 - a. The station header pipe shall incorporate a 2-way plug valve to permit discharge pumping to the lift station force main after isolation of the pumps. Valve shall be manufactured as specified.
 - b. The discharge bypass pipe of the size and configuration indicated on the Drawings shall terminate with a male type quick connect coupling and cap in accordance with Section 40 05 08,.
6. Suction Bypass Piping
 - a. The station shall incorporate piping to permit emergency suction pumping from the lift station wet well.
 - b. The suction bypass pipe of the size and configuration indicated on the Drawings shall terminate with a male type quick connect coupling and cap in accordance with Section 40 05 08.
7. Vacuum Break / Air Release Valves
 - a. The header piping shall be equipped with ball type check valves on the discharge side of each pump to allow a vacuum break to occur, as well as assist purging air from the system in the event that there is insufficient atmospheric pressure available to support the resultant water column. A ball valve and PVC line extending through the lift station base for drainage back to the wet well shall be installed in each pump discharge line.
8. Mechanical Seals: Provide link type mechanical seals suitable for 20 psi working pressure, corrosive service and accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts, where indicated.
 - a. Products and Manufacturers: Provide one of the following:
 - 1) Link-Seal, as manufactured by Thunderline Corporation.
 - 2) Or equal.

G. Valves:

1. General:
 - a. Valve size and location: See Drawings.
 - b. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
 - c. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
 - 1) Valve size.
 - 2) Pressure and temperature ratings.
 - 3) Application (other than water and wastewater).
 - 4) Date of manufacture.
 - 5) Manufacturer's name.
 - d. Provide valves to turn clockwise to close, unless otherwise specified.
 - e. Provide valves with permanent markings for direction to open.

- f. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.
- 2. Materials:
 - a. Valve materials shall be suitable for the associated valve's service or application, as shown.
 - b. Protect wetted parts from galvanic corrosion caused by contact of different metals.
- 3. Valve Joints:
 - a. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
 - b. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
 - c. For stainless steel bolting, except where nitride nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

H. Eccentric Plug Valves:

- 1. Manufacturers: Provide products of one of the following:
 - a. DeZurik.
 - b. Or equal.
- 2. General:
 - a. Provide eccentric-type plug valves each with rectangular ports.
 - b. Minimum Rated Working Pressure:
 - 1) Valves 12-inch Diameter and Smaller: 175 psig.
 - c. Maximum Fluid Temperature: 180 degrees F.
 - d. Minimum Port Area:
 - 1) Valves 20-inch Diameter and Smaller: 100 percent of nominal pipe area.
 - e. Packing and packing gland shall be externally adjustable and accessible without disassembling valve and without removing the actuator.
 - f. Valves shall provide drip-tight, bi-directional shutoff at rated pressures.
 - g. Plug shall have cylindrical seating surface eccentrically offset from center of plug shaft. Interface between plug face and body seat, with plug in closed position, shall be externally adjustable in the field with valve in the line while under pressure.
 - h. Plug shall be supported to top bearing by using spring that is externally adjustable.

3. Materials of Construction:
 - a. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
 - b. Plug:
 - 1) Core: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.
 - 2) Plug Facing: Neoprene.
 - c. For valves up to eight-inch diameter, plugs shall be fully encapsulated with rubber. For valves larger than eight-inch diameter, provide plugs with rubber facing. Minimum thickness of rubber lining shall be 1/8-inch. Rubber hardness shall be a minimum of 70 (Shore A) durometer. Rubber-to-metal bond shall withstand minimum 75-pound pull conforming to ASTM D429 Method B.
4. Seats: Minimum 1/8-inch welded overlay of minimum 90 percent pure nickel on surfaces contacting plug face. Seats shall provide contact area of at least 1/2-inch width all around.
5. Stem Bearings: Sintered, oil impregnated, permanently lubricated of Type 316 stainless steel.
6. Stem Seal: Multiple neoprene V-ring type.
7. All internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts and washers shall be Type 316 stainless steel.
8. Interior Coating and Lining:
 - a. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.
9. Shop Testing:
 - a. Operational Tests:
 - 1) To demonstrate that complete assembly is workable, successfully operate each valve (with actuator mounted directly on valve) three times from fully closed to fully open position and reverse under no-flow condition.
 - b. Leakage Tests:
 - 1) Test each valve for leaks while valve is in closed position.
 - 2) Test valves at rated pressures. During test, valves shall be drip-tight. Test duration shall be at least five minutes for valves up to 20-inch diameter. Tests shall be repeated successfully with pressure in the unseating direction.
 - c. Hydrostatic Test: Test valves to an internal hydrostatic pressure equivalent to twice rated pressure of valve. During hydrostatic test, there shall be no leakage through metal, end joints, and shaft seal, nor shall any part be permanently deformed. Duration of hydrostatic test shall be sufficient to allow visual examination for leakage. Test duration shall be at least one minute for valves eight-inch diameter and smaller, three minutes for valves 10-inch through 20-inch diameter.

10. Gear Actuators for Manually-operated Valves:
 - a. Provide gear actuators on exposed valves, except valves four-inch diameter and smaller located less than five feet above operating floor shall have lever operator.
 - 1) Size gear actuators for valves eight-inch diameter and smaller for 175 psig differential pressure.
 - 2) Size gear actuators for valves larger than eight-inch diameter for the maximum differential pressures:
 - b. Provide actuators capable of holding associated valves in any intermediate position without creeping or vibrating.
 - c. Provide valve position indicator on each actuator. Provide stop-limiting devices for open and closed position. For buried and submerged service actuators, provide position indicators in valve box.
 - d. Provide adjustable stop to adjust seating pressure.
 - e. Make packing accessible for adjustment without requiring removal of actuator from valve, except for valves in buried and submerged service.
 - f. Provide each actuator with gearing totally enclosed.
 - g. Operator shaft and gear sector shall be supported on permanently lubricated bronze or stainless steel bearings.
 - h. Provide metal-encased spring loaded seals in top and bottom covers of gear housing.
 - i. Actuators shall be provided to produce indicated torque with maximum pull of 40 pounds on handwheel or chainwheel and maximum input of 150-foot pounds on operating nuts, for both seating and unseating heads equal to maximum differential pressure rating of valve.
 - j. Actuator components between input and stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and input torque of 300-foot pound for operating nuts when operating against stops.
 - k. Materials of Construction:
 - 1) Housing: Cast-iron, ASTM A126 Class B.
 - 2) Gear Sector: Cast-iron ASTM A126 Class B, or ductile iron ASTM A536.
 - 3) Bearings: Bronze oil-impregnated, or stainless steel.
 - 4) Hardware, including bolts, nuts, washers, set screws, and pins, shall be Type 316 stainless steel.

I. Swing Check Valves:

1. General:
 - a. Provide valves conforming to AWWA C508 and as specified herein.
 - b. Sizes: Four-inch through 24-inch diameter.
 - c. Type: Resilient-seated.
 - d. Rated Working Pressure:
 - e. Smaller than 12-inch Diameter: 175 psig.
 - f. 12-inch Diameter and Larger: 150 psig.
 - g. Provide valves suitable for horizontal or vertical mounting.
 - h. Check valves shall have clear waterway with full-open area equal to nominal pipe size.

- i. Provide check valves with outside adjustable weight and lever.
 - j. Provide valves larger than six-inch diameter with adjustable air cushion chambers.
 - k. Valve seats shall be mechanically attached and shall be field replaceable.
- 2. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
 - a. Body, Disc, Cover and Gland: Cast-iron or ductile iron.
 - b. Disc Arm: Ductile iron.
 - c. Hinge Shaft: Type 316 stainless steel.
 - d. Hinge Shaft Bushings: Bronze, or Type 316 stainless steel for sewage service.
 - e. Shaft End Plate: Type 316 stainless steel.
 - f. Body Seat: Type 316 stainless steel.
 - g. Follower Ring for Rubber Seat on Disc: Type 316 stainless steel.
 - h. Disc Center Pin Assembly: Type 316 stainless steel.
 - i. Air Cushion Chamber:
 - 1) Chamber and Plunger: Bronze.
 - 2) Linkages and Pins: Type 316 stainless steel.
 - 3) Air Check Valve and Tubing: Brass or stainless steel.
 - j. Rubber Items:
 - 1) Applications Up to 180-degree F Fluid Temperature: Buna-N or other synthetic rubber suitable for the application.
 - 2) Applications 180-degrees F and Greater Fluid Temperature: Viton, or other synthetic rubber suitable for the application.
 - k. Internal and external bolting and other hardware; including pins, set screws, studs, bolts, nuts, and washers shall be Type 316 stainless steel.
 - l. Gland Packing: Graphite and Kevlar.
- 3. Interior Coating:
 - a. Valves shall be coated inside. Steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.
- 4. Testing:
 - a. Test each valve in manufacturer's shop in accordance with AWWA C508.
 - b. Allowable Leakage at Rated Pressures: Zero.

J. Station Enclosure (All Stations, Except Station N unless noted otherwise):

- 1. Enclosure Base:
 - a. The enclosure base shall be made with one of the following:
 - 1) Designed for 300 pounds per square foot loading.
 - 2) Castinite Polymer concrete flattop supplied with access hatch preinstalled for each lift station as shown on the project drawings. Flattop shall consist of 90%-94% high purity quartz aggregate with high strength resin epoxy, rated for 18,000 PSI compressive strength.
 - 3) Precast reinforced concrete bonded inside a fiberglass form covering top and sides; designed to function as the wet well top. Provide top of base with a non-skid surface.

- b. Vent Pipe: Shall be PVC Pipe for General Applications in accordance with Section 40 05 31, Thermoplastic Process Pipe.
 - 1) Provide vent pipe of proper size to vent air from wet well to exterior of station enclosure through air tight sealed base penetration.
Provide stainless steel screened vent through enclosure housing.
- 2. Enclosure Housing:
 - a. The enclosure housing shall contain and enclose all valves, electrical equipment, and associated controls and shall be constructed to enhance serviceability by incorporating the following design characteristics:
 - 1) Two access doors per side of the station housing shall be provided. Doors shall be sized and placed to permit routine maintenance operations through the door openings of the housing. For these purposes, routine maintenance shall include frequently performed adjustments and inspections of the electrical components, equipment and valves contained therein.
 - 2) The access doors shall be provided with stainless steel hinge and latch. Hinge shall be the continuous type. Latch shall engage the enclosure at not less than three places and shall be protected by a keyed lock.
 - 3) Housing side shall contain a corrosion resistant screened vent to maximize air flow for enclosure ventilation. The opposite side shall contain the blower.
 - 4) The housing must be removable after detachment from anchorage.
 - b. The enclosure housing shall be manufactured of one of the following:
 - 1) Molded, reinforced orthophthalic polyester resins with a minimum of 30 percent fiberglass, and a maximum of 70 percent resin. Glass fibers shall have a minimum average length of 1-1/4 inches. Resins shall be impervious to micro-organisms, mildew, mold, fungus, corrosive liquids, and gases which are present in the environment surrounding the wet well. Coat interior surfaces with a polyester resin-rich finish. Coat exterior surfaces with a UV resistant pigmented resin, compounded to ensure a long, maintenance-free life. Enclosure interior shall be furnished with spray foam insulation.
 - a) OWNER will choose color from manufacturer's standard color options.
 - 2) Fabricated from ASTM 6061-T6 structural aluminum. housing shall be furnished with Dow Super Tuff-R 1" thick poly coated closed cell foam insulation, or equal, which shall be installed in the roof, doors, and side wall panels. The insulation installed in the side walls and doors shall have a minimum rating of R6.5 and the insulation installed in the roof shall have a minimum rating of R12.5.
 - a) Outside surfaces of the housing shall have an aluminum ASTM 3003 mill finish.

- 3) All interior surfaces of the enclosure housing shall be coated with a surface protection designed to provide long life and maintenance-free service, abrasion resistance, and protection from sewage, greases, oils, gasoline, and be impervious to microorganisms, mildew, mold, fungus, corrosive liquids, and gases which are expected to be present in the environment surrounding a sanitary sewage wet well.
3. Enclosure Appurtenances:
 - a. Ventilation Blower:
 - 1) Provide ventilation blower sized to change station enclosure housing air a minimum of once every 2 minutes. Blower shall operate automatically, with variable temperature on and off control capability. Protect blower motor and control circuit by a thermal-magnetic air circuit breaker to provide overcurrent and overload protection. Protect blower inlet made of noncorrosive materials from entrance of rain, snow, rocks, and other foreign matter. Include high housing temperature alarm system and/or blower failure alarm.
 - b. Station Heater:
 - 1) Provide electric heater mounted in the enclosure housing for freeze protection. Heater shall provide a minimum of 5,000 BTU heat output per hour. The electric heat shall be thermostatically controlled and shall energize automatically based on field adjustable set points. The 115 VAC electric heater control circuit shall incorporate a thermal-magnetic circuit breaker providing overcurrent and overload protection, and shall be powered by the lift station control panel or local 120V power distribution panel. Include adjustable thermostat and a low enclosure temperature alarm system and/or heater failure alarm.
 - c. Housing Lighting:
 - 1) Enclosure housing shall be provided with LED waterproof light fixture(s), installed in rigid aluminum housing which will adequately light the internal features of the station for maintenance and operational purposes, including adequate illumination of the lift station control panel.
 - d. Yard Lighting: Provide general purpose LED site lighting, controlled with switch located in enclosure housing, in area of wet well and enclosure housing. Fixture shall be mounted on station enclosure housing utilize a stanchion mount as required for heights and lighting distribution requirements, or on adjacent existing electrical service pole. Lighting circuit shall be protected by a 15-ampere thermal-magnetic circuit breaker and shall be powered from pump station control panel.
 - e. Duplex Ground Fault Circuit Interrupter (GFCI) receptacle: Provide at least one 115 VAC, 60 Hz, single phase electric receptacle mounted in the lift station enclosure. Receptacle circuit shall be protected by a 15-ampere thermal-magnetic circuit breaker and shall be powered from pump station control panel.
 - 1) Provide an additional 120V circuit for an additional receptacle mounted in the Station P meter vault for powering the 120V sump pump.

- f. Provide a gasketed vapor tight transition between wet well and station enclosure housing for pump cables, level controls and wiring.
- g. The lift station enclosure housing shall be equipped with minimum 3 KVA step-down transformer to supply 115 VAC, single phase for the control and auxiliary equipment as required.
 - 1) The primary and secondary side of the transformer to be protected by a thermal magnetic circuit breaker, sized per the National Electric Code to meet the power requirements of the transformer.
- h. Alarm and Status Light (External):
 - 1) Provide one 115 VAC LED alarm light fixture with vapor-tight shatter resistant red globe, conduit box, and mounting base; factory-mounted on exterior of the station enclosure housing. Mount on Control Panel for Station N.

K. Portable Pump Hoist:

- 1. Provide electrically driven portable pump hoisting capabilities for each station. Provide hoist with recessed socket type support cast adjacent to enclosure base slab or flush pedestal type mount secured to enclosure base slab in enclosure housing, as recommended by station supplier. Hoist shall have capacity sufficient to hoist one associated pump at a time. Provide at least 4 hoists total and at least two for each range of hoist capacity needed for the 17 stations excluding Station N. Provide one hoist for exclusive use at Station N. Hoist circuit shall be protected by a sufficiently sized thermal-magnetic circuit breaker and shall be powered from pump station control panel.

L. Enclosure Base Wet Well Access Doors. (See Specification Section 33 05 13 - Manholes and Structures for Station N Access Hatch.)

- 1. Provide in enclosure base for installation and removal of specified pumps and wet well access.
 - a. Aluminum Access Hatch – Angle Frame Type:
 - 1) Design Live Load: 300 pounds per square foot.
 - b. Cover: Not less than 1/4-inch thick aluminum diamond-pattern plate cover. Provide flush drop handle for lifting the cover.
 - c. Frame: Extruded aluminum angle frame with manufacturer's standard anchor tabs or continuous anchor flange around the perimeter for anchorage to concrete.
 - d. Hinges: Tamper-resistant, heavy-duty hinges with Type 316 stainless steel pin fastened to leaf (door) with Type 316 stainless steel tamper-resistant bolts.
 - e. Latch: Type 316 stainless steel, watertight, slam-type latch with inside lever handle and outside, removable exterior turn/lift handle fastened to leaf (door) with tamper-resistant Type 316 stainless steel bolts. Latch release shall be protected by a flush, gasketed, removable screw plug.
 - f. Lift Assistance: Open-style stainless steel compression springs with Type 316 stainless steel guide tubes. Automatic Type 316 stainless steel hold-open arm with grip handle release.

- g. Fall-Through Prevention System: Provide access hatch cover manufacturer's standard safety grating of FRP or aluminum, constructed for live load capacity of not less than 300 psf. Provide hinges and lift-assist to allow grating sections to automatically lock in place in full-open 90-degree position. Provide hold-open arm and release assembly of aluminum or Type 316 stainless steel. Grating shall be colored OSHA "Safety Yellow" or "Safety Orange".
- h. Finish: Mill finish.

M. Lift Station Controls:

- 1. Provide lift stations with the following wet well level monitoring:
 - a. Level transmitter - submersible pressure type (for domestic wastewater):
 - 1) Pumps shall be controlled based on fluid level in wet well. Level measurement system shall be furnished by pump Supplier and shall be submersible pressure transmitter
 - 2) Type: Measuring level by continuously measuring hydrostatic pressure via its sensing element, an ion implanted silicon semiconductor chip. Data is transmitted by an analog, 4 to 20 mA DC output signal.
 - 3) Performance Requirements:
 - a) Accuracy: ± 0.25 percent full scale.
 - b) Zero Offset: ± 0.50 percent full scale.
 - c) Span: ± 0.50 percent full scale.
 - d) Temperature Ranges: -40 to 176 degrees F.
 - 4) Construction Features:
 - a) Diaphragm: Type 316L stainless steel.
 - b) Housing: Type 316 stainless steel.
 - c) Hazardous Classification: Level transmitter shall be explosion proof Class I Division 1 rated.
 - d) Cable shall be provided of required length and fully submersible construction.
 - e) Power supply: 12 to 28 VDC with surge and lightning protection.
 - f) Electrical Connection: Attached 3-wire, 20-gauge polyethylene shielded unspliced cable.
 - g) Panel mounted meter shall be factory calibrated for required range, shall accept 4 to 20 mA DC input, shall have a local display in feet of water, shall be NEMA 4X rated and have two relay outputs for low level alarm. Level shall also be displayed on HMI Screen.

- b. Level switches - multipoint float type (backup)
 - 1) Provide two (2) non-mercury float switches for a redundant station level control system that is independent from the primary station level control system. The independent redundant float control system consists of two (2) non-mercury float switches, 316 stainless steelfloat tree with means to secure cables, an intrinsically safe barrier relay and an independent controller. The Low Level float (Pump Off) is positioned below all primary pump-off setpoints. The high level float (Pump On) is positioned above all primary pump-on setpoints. If the high-level float switch is triggered and the timer expires, a pump will start and a 'Independent Redundant Float Control Alarm' will be triggered. If the high level persists, the second pump will start after an adjustable time period. When the wet well level reaches the low level float, the pump(s) will shut off. The independent redundant float control system includes automatic pump alternation. Dry contacts wired to terminal blocks will be provided for the float control active alarm circuit. The independent redundant float control system will remain latched until manually reset at the control panel.
- 2. Control Panels:
 - a. The lift station shall come with a duplex or triplex, as required by the Design and Performance Criteria, with electrically interlocked door, preventing opening without disconnecting power. Before delivery, the control panel shall be tested with the lift station as a complete working system at the lift station manufacturer's facility.
 - b. Panel Enclosure:
 - 1) Except for Station N, electrical control equipment shall be mounted within the lift station enclosure structure in a NEMA 3R rated enclosure. Control components shall be mounted on back panels secured to enclosure with all control devices and instruments secured to the sub-plate with screws and lock washers.
 - 2) Electrical control equipment at Station N shall be mounted outside in a lockable NEMA 4X rated outer enclosure, with a NEMA 1 rated inner enclosure that houses operator interface and control equipment. Control components shall be mounted on removable back panels secured to enclosure with all control devices and instruments secured to the sub-plate with screws and lock washers.
 - 3) The control panel shall be equipped with vapor emission type corrosion inhibitors.
 - 4) All control devices shall be clearly labeled to indicate function.
 - c. UL Label Requirement for Control Panel:
 - 1) Controls shall conform to third party safety certification such as Underwriters Laboratories (UL). The panel enclosure, and all components mounted on the sub-panel or control cover shall conform to UL descriptions and procedures.

- d. Circuit Breakers and Operating mechanisms:
 - 1) Properly sized heavy-duty circuit breakers shall be furnished for each pump motor.
 - 2) A normal duty thermal magnetic circuit breaker shall protect all control circuits by interrupting control power.
 - 3) The control panel shall be equipped to monitor the incoming power and shut down the pump motors when required to protect the motor(s) from damage caused by phase reversal, phase loss, voltage unbalance, high voltage, and low voltage. An adjustable time delay shall be provided to minimize nuisance trips. The motor(s) shall automatically restart, following an adjustable time delay, when power conditions return to normal.
 - 4) Each control panel shall be equipped with an with electrically interlocked door, preventing opening without disconnecting power.
- e. The control panel shall be equipped with a UL Type 2 surge protective device to minimize damage to the pump motors and control systems from transient voltage surges. Visual status indication shall be provided to show the operating state of each phase.
- f. The control panel shall be capable of monitoring and displaying power monitoring real-time voltage and amperage draw of each motor including constant speed motors. Intrinsic power monitoring capability of VFDs is suitable to monitoring voltage and amperage and no additional power monitoring equipment is required.
- g. A high pump motor temperature protection circuit shall override the level control and shut down the pump motor(s) when required to protect the pump motor from excessive temperature.
 - 1) A thermostat, or similar control logic, shall cause each pump to be shut down in the event of a high pump motor temperature condition.
 - 2) If temperature rises to a level sufficient to cause damage, the thermostat causes the pump shutdown circuit to interrupt power to the motor.
 - 3) A visible indicator located on the control panel door shall indicate motor stopped due to high temperature.
 - 4) The motor shall remain locked out until the pump has cooled and circuit has been manually reset.
- h. Variable Frequency Drives:
 - 1) NEMA Rated Allen Bradley or approved equal, variable frequency drives (VFDs) are to be supplied and installed within the enclosure as part of the lift station controls required by the Design and Performance Criteria.
 - 2) The VFDs shall be capable of operation under any combination of weather conditions commonly experienced throughout the year without mechanical or electrical damage. The enclosure shall include heating and/or cooling equipment required to preserve the VFDs from damaged caused by extreme weather as required by the Design and Performance Criteria for control enclosures based on the conditioning of the space in which they are installed.

- 3) VFD functions for this lift station shall include, but are not limited to, the following:
 - a) Acceleration and deceleration time independently adjustable from 0.1 to 3600.0 seconds (selectable ranges).
 - b) Volts/Hertz patterns shall be user selectable.
 - c) Maximum and minimum frequency limit adjustments.
 - d) Forward and reverse rotation.
- 4) When the VFD inverter trips out on a fault, the fault relay shall activate, and the display shall indicate the reason for the trip as follows:
 - a) Overcurrent.
 - b) Short circuit.
 - c) Overload.
 - d) Overvoltage.
 - e) Under voltage.
 - f) Overheat.
 - g) Ground fault.
 - h) Motor stalled.
 - i) Power supply fault.
- 5) Auto restart shall occur when the inverter faults.
 - a) Auto restart shall be adjustable up to 9 attempts with a 0.5 to 30 second interval.
 - b) Auto restart will not be attempted for ground fault, output shorted, transistor shorted or internal microprocessor fault but will trip out immediately, activate the fault relay and make the appropriate indication on the display.
 - c) Information regarding the last 4 faults shall be maintained in event of a power loss. The microprocessor shall save the status of the inverter at the time of the fault and make that information available on the digital display.
- 6) Harmonic protection requirements
 - a) All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a “dedicated system” in IEEE 519 Table 10.2.
 - b) With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from either or both the utility and generator sources, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).
 - (1) Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
 - (2) Current distortion: IEEE 519 Table 10.3, based on $ISC/IL < 20$.
 - c) Point of Common Coupling (PCC) shall be considered:
 - (1) Building service entrance switchgear, switchboard or MCC.
 - (2) Each MCC, switchboard, switchgear, or panelboard supplying a VFD branch circuit.

- d) Provide the following topologies:
 - (1) 6-pulse rectifier topology with tuned passive filter with controls such that the filter is not energized when VFD is off or starting. 12-pulse rectifier topology for each VFDs with input current ratings in excess of 11 A.
 - (2) 18-pulse rectifier topology for each VFDs with input current ratings in excess of 34 A.
- e) VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.
- f) Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at each PCC according to the requirements of IEEE 519 Section 9.
 - (1) Values in excess of specified limits require correction by contractor and re-measurement.
 - (2) Provide certification of compliant measurements as part of Field Service
- i. Control Systems and Logic:
 - 1) The lift station control system shall be pre-programmed or wired to provide the following:
 - a) Pump start/stop based on level control.
 - b) Pump speed vs level control.
 - c) Pump alternation, or selected pump designation (operator choice).
 - d) Jump to next pump on lead failure.
 - e) High and low-level alarms.
 - f) Pump motor high temperature shutdown.
 - g) Pump motor seal leak delayed shutdown.
 - h) Drive fault alarm.
 - i) Power failure alarm
 - j) Station trouble alarm visible through alarm light on station enclosure; except for Station N mount on Control Panel.
 - 2) External Controls & Interlocks:
 - a) For Stations equipped with automatic standby generators (Stations D, E, H, J, N, P, & S), a normally open (NO) aux contact on the generator Automatic Transfer Switch (ATS) shall provide position indication of the ATS (open - Normal Power, closed-Emergency Power) in order to provide emergency power status.
 - (1) In the event of emergency power indication, pumps shall restart on a minimum 3-minute delay to ensure the pump has had adequate time to come to a stop before restarting. Pump startup shall also be staggered by a minimum of 1 minute after the first pump has started in order to limit the starting load on the generator.

- b) For Station N, the emergency position indication of the ATS shall limit the pump station to a maximum of (2) total concurrently running pumps. The third pump shall be permitted to engage when normal power returns.
- c) Station N Bypass Pump Lockout:
 - (1) Provide Normally open (NO) relay output contact in pump station control panel for bypass pump lockout.
 - (a) Existing Bypass pump shall not be permitted to run while any sanitary lift station pump is running. "Pump Running" status (for any of the 3 pumps) shall initiate a contact closure of the "Bypass Pump Lockout" relay output contact. "Bypass Pump Lockout" relay output contact shall be wired to the existing Bypass Pump VFD in existing building as shown on the plan drawings. Utilize spare Discrete Input (DI) in PowerFlex 400 VFD to indicate "pump running" signal from new lift station pump control panel.
 - (2) Reconfigure Bypass Pump VFD programming to incorporate "Bypass Pump Lockout" configuration upon contact closure at spare discrete input on existing PowerFlex 400 VFD.
 - (3) High Water Alarm
 - (a) Provide a high water alarm from the float switches installed in the following locations: Station P meter vault & Station N valve vault.
 - (b) High Water Alarm wiring shall terminate at a discrete input into the pump station control panel for each float switch. See Section 33 05 13 - Manholes And Structures for requirements.
- 3) Logical wet well level control as follows:
 - a) The level control system shall utilize the programmable controller (PLC) sequencer to select first one pump, then the second pump, then the third (if applicable – Stations E, H, & N) to run as lead pump for a pumping cycle. Alternation shall occur at the end of a pumping cycle or if one pump runs as the lead pump for an excessive time.
 - b) Level and speed controls shall include logical comparator setpoints. Settings shall be provided to control the levels at which the pumps start and stop as well as level endpoints for minimum and maximum speed. Two sets of speed setpoints shall be provided (three for triplex stations). The first set point will be enabled when a single pump is running. The second set point shall be enabled when two pumps are running. The third set point shall be enabled when three pumps are running (triplex stations).

- c) Each of the level and pump speed control settings shall be adjustable on the control panel display screen and accessible to the operator without opening the control panel. Controls shall be provided to enable the operator to read and adjust the selected levels and speeds on the operator interface. Setpoint adjustments which require hard wiring, the use of electronic test equipment or artificial level simulation are not acceptable.
- d) For lift stations with constant speed pumps upon operator selection of automatic operation, the PLC shall start the motor for one pump when the liquid level in the wet well rises to the "lead pump start level". When the liquid is lowered to the "lead pump stop level", the PLC shall stop this pump. These actions shall constitute one pumping cycle. Should the wet well level continue to rise, the PLC shall start the second pump when the liquid reaches the "lag pump start level" so that both pumps will be operating.
- e) For lift station with variable speed-controlled pumps, when a single pump is running, and the wet well is equal to the "1 pump minimum level", the drive will first run at the "1 pump minimum speed". As the level rises, drive speed will increase to the "1 pump maximum speed" when the wet well level is equal to the "1 pump maximum level", the second pump will be required to engage, and the "1 pump" scenario settings will be disabled, and the control will use the "2 pump" level and speed scenario and settings. For triplex stations, as the level rises, drive speed will increase to the "2 pump maximum speed" when the wet well level is equal to the "2 pump maximum level", the third pump will be required to engage, and the "2 pump" scenario settings will be disabled, and the control will use the "3 pump" level and speed scenario and settings. The lower limit for the 3 pump (triplex stations), 2 pump, and 1 pump scenarios shall be set in order for the control system to transition from 3 pumps (triplex stations) to 2 pumps, from 2 pumps to 1 pump, and from 1 pump to off, respectively, when the level or speed reaches a determined value.
- f) For lift stations with variable speed-controlled pumps, controls shall automatically provide reverse rotation of pump on operator adjustable frequency of individual pump starts.
- g) Level control range shall be 0 to 15 feet of water. Speed control range shall be 20 to 60 hertz. Overall repeat accuracy shall be (plus/minus) 0.1 feet of water.

h) Operating and Alarm Levels:

STEP	Level*	Two Pump Control Rising Level	Three Pump Control Rising Level
1A	0.50	Low Level Alarm "Off"	Low Level Alarm "Off"
2A	2.75	Start of First Pump	Start of First Pump
3A	5.00	Start the Second Pump	Start the Second Pump
4A	7.50	NA	Start the Third Pump
5A	8.00	High Level Alarm "On"	High Level Alarm "On"
		Falling Level	Falling Level
5B	7.50	High Level Alarm "Off"	High Level Alarm "Off"
4B	2.00	NA	Stop the Third Pump
3B	1.50	Stop the Second Pump	Stop the Second Pump
2B	1.00	Stop the First Pump	Stop the First Pump
1B	0.00	Low Level Alarm "On"	Low Level Alarm "On"

* Level indicates the elevation in feet above the top of pump casing.

- 4) Alarms and shutdown routines shall operate as follows:
 - a) Condition abnormal: The general alarm pilot light will quick flash until silenced, then slow flash until reset, then glow steady until condition returns to normal, then off. Operator interface will display the alarm when acknowledged. External alarm indicator (light) will be active until silenced, and then off.
 - b) Condition abnormal then returns to normal: The general alarm pilot light will quick flash until silenced, then slow flash until reset, then off. The operator interface will display the alarm when acknowledged. The external alarm indicator (light) will be active until silenced, and then off.
 - c) Subsequent alarms will re-alarm when silenced or reset.
- j. Each pump station shall be equipped with minimum 6" HMI (Human Machine Interface) screen (stations E, & H shall include a 10" HMI screen) for monitoring and control of lift stations and shall be equipped with the following displays and functions:
 - 1) Main Menu.
 - 2) Wet well Level.
 - 3) Wet Well Level Simulation.
 - 4) Low Wet Well Level Alarm Status.
 - 5) High Wet Well Level Alarm Status.
 - 6) Pump High Temperature Status.
 - 7) Pump Seal Leak Status.
 - 8) Pump Sequence Selection.
 - 9) Alarm Silence.
 - 10) Alarm Reset.
 - 11) General Alarm Test.
 - 12) Lead Level Start/Stop Setpoints.
 - 13) Lag Level Start/Stop Setpoints.
 - 14) Low Wet Well Level Alarm Setpoints.
 - 15) High Wet Well Level Alarm Setpoints.

- 16) Speed/Level Setpoints (1 pump running).
 - 17) Speed/Level Setpoints (2 pumps running).
 - 18) Speed/Level Setpoints (3 pumps running) (triplex stations).
 - 19) Pump Start Delay Setpoint.
 - 20) Alternation Time Interval Setpoint.
 - 21) Total running time of each pump in "hours" and "tenths of hours".
 - 22) VFD (if included) ramp speed setpoint.
 - 23) Realtime VFD (if included) drive frequency and corresponding motor speed as a % of maximum allowable.
 - 24) Realtime power draw.
 - 25) Realtime amperage draw.
 - 26) Realtime motor starter load-side voltage.
 - 27) Realtime VFD (if included) line-side & load-side voltage.
 - 28) Normal/Emergency power source: For Stations equipped with automatic standby generators (Stations D, E, H, J, P, & S), a normally open (NO) aux contact on the generator Automatic Transfer Switch (ATS) shall provide position indication of the ATS (open - Normal Power, closed-Emergency Power) in order to provide emergency power status.
- k. Pump mode selector switches ("HOA ("Hand, Off, Auto") Switches") shall permit manual start or stop of each pump individually or permit automatic operation under control of the liquid level control system.
 - 1) Manual operation shall override all shutdown systems, except the motor overload relays.
 - 2) Selector switches to be oil-tight design.
 - l. Provisions for automatic pump alternation or manual selection shall be provided for the user's choice.
 - m. Electromechanical relays and timers, when used, shall be equipped with appropriately sized, NEMA rated, 120 VAC coils and contacts.
 - n. Control logic shall be accomplished using programmable controllers (PLC). Electromechanical relays may be used when necessary. However, the primary control logic shall be performed by the PLC.
 - o. The PLC shall be Allen Bradley MicroLogix 1400 with DNP3 protocol for interfacing with the cloud based monitoring system and including the following:
 - 1) The PLC shall be equipped with a CPU with a minimum of 1 MB of user memory and 160 I/O points.
 - 2) Ethernet/IP communication ports supporting ring topologies and 1 USB port for firmware download and programming.
 - 3) The Controller shall utilize the small applications I/O modules.
 - 4) The Controller shall be designed to implement consumed tag, event instruction, embedded inputs, remote I/O, axis, and motion event triggers.
 - 5) The controller shall be equipped to handle up to 32 Controller Tasks and 100 programs per task.
 - 6) The PLC shall operate on 24VDC power and be equipped with a 24VDC embedded power supply.

- 7) An uninterruptable power supply (UPS) with minimum 90-minute capacity shall be included to power PLC, local status/alarm lights as well as Hosted SCADA Service equipment.
- 8) A 1784-SD1 (1GB) Memory Module shall be shipped with the controller.
- 9) The controller will contain, at least but not limited to, embedded digital I/O. The controller shall accept all digital and analog I/O necessary to accomplish the herein specified operation.
- 10) A minimum of 10% spare space for I/O used shall be supplied both for I/O points and I/O Cards.
- 11) The program logic shall be stored on the processor as well as on a programmable, read only 1 GB SD card (shipped with controller).
 - a) The memory module shall auto load and run when installed in the programmable control processor.
 - b) This feature is included to facilitate field repair or replacement of the programmable control hardware without the use of programming terminals or personal computers.
- 12) The PLC shall communicate with the drive using an Ethernet/IP but can also support other communication protocols such as ControlNet, or Device Net networks.
- 13) The PLC shall issue starter and drive start/stop and speed commands. Drive status shall be communicated to the PLC using Ethernet/IP.
- 14) The drive shall be configured to operate manually without the use of the PLC
- p. A Human Machine Interface (HMI) shall be provided for user input and display at all stations.
 - 1) The HMI display shall be at least 6 inches in size for all Stations, except Stations E, & H which shall be at least 10 inches.
 - 2) The HMI shall be mounted on the front of the control panel with other operator controls and shall be compatible with the PLC communication protocol.
 - 3) The HMI interface shall be a backlit, touch-screen terminal.
 - 4) The HMI interface program shall be stored on a removable storage device like a Secure Digital (SD) card.
- q. Operation and maintenance manual shall be provided with complete ladder logic program documentation including English names, rung comments, and coil/contact cross-references.
- r. Operation and maintenance manual shall include delivered programming logic and instructions for Owner/user programming and implementation.
- s. Provide services for field programming for a period of at least 1 year.
3. Wiring:
 - a. The lift stations except for Station N, as furnished by the supplier, shall be completely wired, except for power feed lines to the branch circuit breakers and final connections to remote alarm devices, which shall be completed by the CONTRACTOR in the field.
 - b. All wiring, workmanship, and schematic wiring diagrams shall comply with applicable standards and specifications of the National Electric Code (NEC).

- c. Control circuit wiring inside the panel, with exception of internal wiring of individual components, shall be 16-gauge minimum, type MTW (Machine Tool Wire) or THW (Thermal High Heat Wire), 600 volts. Power wiring to be 14-gauge minimum. Motor branch wiring shall be 10-gauge minimum.
- d. All user serviceable wiring shall be type MTW or THW, 600 volts, color coded as follows:
 - 1) Line and Load Circuits, AC or DC power: Black
 - 2) AC Control Circuit Less Than Line Voltage: Red
 - 3) DC Control Circuit: Blue
 - 4) Interlock Control Circuit, from External Source: Yellow
 - 5) Equipment Grounding Conductor: Green
 - 6) Current Carrying Ground: White
 - 7) Hot with Circuit Breaker Open: Orange
- e. Wires must be clearly numbered at each end in conformance with applicable standards.
- f. All wire connectors in the control panel shall be done in a uniform commercial wiring practice utilizing ring-tongue type with nylon insulated shanks.
- g. All wires on the sub-plate shall be bundled and tied.
- h. All wires extending from components mounted on door shall terminate at a terminal block mounted on the back panel and wires connected to door mounted components must be tied and bundled in accordance with good commercial practice. Bundles shall be made flexible at the hinged side of the enclosure. Adequate length and flex shall allow the door to swing full open without undue stress or abrasion. Bundles shall be held on each side of hinge by mechanical fastening devices.
- i. All wiring outside the panel shall be routed through conduit.
- 4. Conduit:
 - a. Factory installed conduit shall conform to following requirements:
 - 1) All conduit and fittings to be UL listed.
 - 2) Liquid tight flexible metal conduit to be constructed of smooth, flexible galvanized steel core with smooth abrasion resistant, liquid tight polyvinyl chloride cover.
 - 3) Conduit to be supported in accordance with articles 346, 347, and 350 of the National Electric Code.
 - 4) Conduit shall be sized according to the National Electric Code.
- 5. Grounding:
 - a. Lift station manufacturer shall ground all electrical equipment inside the lift station to the control panel back plate. All paint must be removed from the grounding mounting surface before making final connection.
 - b. The Contractor shall provide a 3/4"x10' earth-driven copper ground rod with grounding conductor connection to the lift station main grounding lug in accordance with the National Electric Code (NEC) per NEC Table 250.66.

6. Control Equipment Marking:
 - a. Permanent corrosion resistant name plate(s) shall be attached to the control and include following information:
 - 1) Equipment serial number
 - 2) Control panel short circuit rating
 - 3) Supply voltage, phase and frequency
 - 4) Current rating of the minimum main conductor
 - 5) Electrical wiring diagram number
 - 6) Motor horsepower and full load current
 - 7) Motor overload heater element
 - 8) Motor circuit breaker trip current rating
 - 9) Name and location of equipment manufacturer
 - b. Control components shall be permanently marked using the same identification keys shown on the electrical diagram. Labels shall be mounted adjacent to device being identified.
 - c. Switches, indicators, and instruments mounted through the control panel door shall be labeled to indicate function, position, etc. Labels shall be mounted adjacent to, or above the device

2.2 FINISHES

- A. Shop Finishing:
 1. At the factory, pumps, motors, and appurtenances shall receive manufacturer's standard finish paint system suitable for service conditions specified in this Section.
 2. Coat machined, polished, and non-ferrous surfaces with corrosion prevention compound.

2.3 SOURCE QUALITY CONTROL

- A. Shop Tests: Shop Test all equipment provided under this Section.
 1. All components including the pumps, motors, valves, piping and controls shall be tested individually or as a complete working system. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rates speed and horsepower..
- B. Motor Tests and Data:
 1. For each motor, provide an inspection report for job motor or a previously tested electrically duplicate motor. Provide the following minimum data:
 - a. Running light current.
 - b. Locked rotor current.
 - c. Winding resistance measurement.
 - d. High potential test.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which products are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install products in conformance with manufacturer's instructions and recommendations, and the Contract Documents.
- B. Anchorages:
 - 1. Install pumps per equipment manufacturer's recommendations and the Contract Documents.
- C. General:
 - 1. Conform to ANSI/HI 1.4.
 - 2. Perform all fitting required for installation. Set products accurately in location, alignment, and elevation, plumb and true.
 - 3. Provide utility connections per the Contract Documents. Support piping and valves independent of pump. Verify that utilities and valves are tested and operational before placing equipment into operation. When pumps are connected to piping with rigid hardware, connection of discharge nozzle to piping shall conform to ANSI/HI 9.6.2.
 - 4. Align and adjust products and piping in presence of ENGINEER
 - 5. Provide for initial operation lubricants recommended by equipment manufacturer
 - 6. Prior to energizing motor driven equipment, rotate drive motor by an external source to demonstrate free operation of mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.
- D. Conform to Section 01 75 11, Checkout and Startup Procedures.

3.3 FIELD FINISHING

- A. Field painting shall conform to Section 09 91 00, Painting.
 - 1. Touch-up of factory-applied finishes shall be compatible with factory-applied finish and specified service conditions.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Services: Provide qualified, factory-trained serviceman to perform the following:
 - 1. Instruct CONTRACTOR on installing equipment.
 - 2. Inspect and adjust equipment after installation to ensure proper operation.

3. Test-operate the products in presence of ENGINEER and verify that equipment conforms to Contract Documents.
4. Instruct OWNER's personnel on operating and maintaining the products.
5. Manufacturer's representative shall make a minimum of two visits to each lift station on the project, with a minimum of two hours onsite for each visit. First visit shall be for assistance in installing equipment ; second visit shall be for checking completed installation and start-up of system. Representative shall revisit the Site as often as necessary until installation is acceptable.
6. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of products. Training requirements, duration of instruction, and other qualifications shall be per Section 01 79 23, Instruction of Operations and Maintenance Personnel.
7. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to Site shall be included in the Contract Price.

B. Site Tests:

1. Following installation, CONTRACTOR and qualified field service representative of equipment manufacturer shall conduct operating tests of all equipment, functions, and controls at Site, in presence of ENGINEER. Should tests result in malfunction, make necessary repairs, revisions, and adjustments and restart test from beginning. Repeat tests and repairs, revisions, and adjustments until, in opinion of ENGINEER, installation is complete and equipment is functioning properly and accurately, and is ready for permanent operation.
2. Field Operating Test:
 - a. When station is complete and ready for operation as intended CONTRACTOR shall supply water in volume adequate to operate station through several pumping cycles.
 - b. Field test equipment and its controls in local mode, followed by demonstrating proper operation and controls in automatic mode. Demonstrate that each part and component of system individually and all parts and components together function properly in manner intended.
 - 1) Observe and record operation of pumps, suction and discharge gauge readings, ampere draw, pump controls, and liquid level controls.
 - 2) Verify proper transfer and operation of generator at stations were relocated.
 - 3) Check calibration of all instrumentation equipment.
 - 4) All testing equipment and manpower shall be by CONTRACTOR.
 - c. Conform to applicable provisions of ANSI/HI 9.6.5.

C. 10-Day Operating Period:

1. Following completion of the Field Operating Test, when, in the opinion of the ENGINEER, the installation is ready for permanent operation, flow from the influent sewer can be restored to the wet well, beginning the 10-day period of operation required per Supplementary Condition 15.03.B.

+ + END OF SECTION + +

SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
 - a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections or other contracts.
 - b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
 - c. Work on or affecting existing exposed piping.
 - d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
 - e. Supports, restraints, and other anchors.
 - f. Field quality control, including testing.
 - g. Cleaning and disinfecting.
 - h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.
2. Coordinate with appropriate piping Sections of Division 40, Mechanical.

C. Related Sections:

1. Section 09 91 00, Painting.
2. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. ANSI/AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.

3. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) and Molecularly oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
4. AWWA M23, PVC Piping - Design and Installation.
5. AWWA M41, Ductile-Iron Pipe and Fittings.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with requirements and recommendations of authorities having jurisdiction over the Work, including:
 - a. OWNER.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Detailed drawings in plan and, as applicable, section.
 - b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping,
2. Testing Plans, Procedures, and Testing Limitations
 - a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.

B. Informational Submittals: Submit the following:

1. Certificates:
 - a. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
 - a. Welder's certificate in compliance with Paragraph 3.1.E.7.c of this Section.
2. Source Quality Control Submittals:
 - a. Submit copies of testing report for each test.
3. Site Quality Control Reports:
 - a. Submit copies of testing report for each test.

C. Closeout Submittals: Submit the following:

1. Record Documentation:
 - a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
 - b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
 - c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
 - d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Delivery:
 - 1. Deliver products to Site to ensure uninterrupted progress of the Work.
 - 2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
 - 3. Conform to requirements of Section 01 65 00, Product Delivery Requirements.
- B. Storage:
 - 1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
 - 2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.
 - 3. Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements.
- C. Handling:
 - 1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
 - 2. Avoid unnecessary handling of pipe.
 - 3. Keep pipe interiors free of dirt and foreign matter.
 - 4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
 - 5. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Integration.
- B. Markings and Identification:
 - 1. Pipe Markings:
 - a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
 - b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
 - 2. Pipe Identification Markers and Arrows: Refer to Section 10 14 00, Signage.

- C. Appurtenances: Provide products that comply with:
 - 1. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General:
 - 1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.
 - 2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
 - 3. Provide pipe manufacturer's installation specialist at Site as specified on this Section.
- B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
 - 1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
 - 2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
 - 3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
 - 4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.
- C. Piping Installation:
 - 1. Conform to manufacturer's instructions and requirements of standards and manuals listed in this Section, as applicable:
 - a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
 - b. Steel Pipe: Michigan Mechanical Code and all other applicable state and local regulations, as well as the requirements of the governing gas utility company..
 - c. Thermoplastic Pipe: AWWA M23
 - 2. Install straight runs true to line and elevation.
 - 3. Install vertical pipe truly plumb in all directions.

4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.
7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.
8. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
9. Additional General Requirements for FRP and Thermoplastic Piping:
 - a. Utilize wide band supports as recommended by pipe manufacturer and approved by ENGINEER to minimize localized stresses.
 - b. Provide piping passing through walls with a sleeve of wearing material to prevent abrasion damage to piping.
 - c. Provide anchored supports at elbows, valves, bends in piping, and at connections to equipment and tanks.
 - d. Spacing of supports shall be in accordance with the manufacturer's published recommendations at maximum design operating temperature of pipe.
 - e. Provide U-clamps with wide band circumferential contact.
 - f. Provide guides on long runs of piping to maintain alignment and reduce chance of elastic failure of pipe. Space guides as recommended by pipe manufacturer.
 - g. Provide anchored supports to restrain joints that allow expansion. Minimize use of bellows style joints. Where required and approved by the ENGINEER provide bellows style joints with low axial force to take up pipe expansion. Flexible connectors may be used to absorb thermal movement when approved in writing by ENGINEER.

D. Jointing Pipe:

1. General:
 - a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
 - b. Cut piping accurately and squarely and install without forcing or springing.

- c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
 - d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
- 2. Ductile Iron and Steel Flanged Joints:
 - a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
 - b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
 - c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
 - d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
 - e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
 - f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09 91 00, Painting, for material of pipe and fittings being joined.
- 3. Thermoplastic Pipe Joints:
 - a. Solvent Cement Welded Joints:
 - 1) Bevel pipe ends and remove all burrs before making joint. Clean pipe and fittings thoroughly. Do not make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
 - 2) Use solvent cement supplied or recommended by pipe manufacturer.
 - 3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
 - 4) Implement appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit fluid when flushing or filling pipelines to prevent compression of gases within pipes.

E.

E. Installing Valves and Accessories:

- 1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.
- 2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
- 3. Position swing check valves and butterfly valves so that they do not conflict with upstream and downstream elements of the piping system.

F. Unions:

1. Install dielectric unions where dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

3.3 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:

1. Locations of existing piping shown on Drawings is approximate.
2. Determine the true location of existing piping to which connections are to be made, crossed, and that could be disturbed, and determine location of other facilities that could be affected by the Work.

B. Taking Existing Pipelines Out of Service:

1. Conform to Section 01 14 16, Coordination with Owner's Operations.

C. Work on Existing Pipelines:

1. Cut or tap pipes as shown or required with machines and tools specifically designed for cutting or tapping pipelines.
2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations and Section 01 73 24, Connections to Existing Facilities.

3.4 PAINTING

- A. Field painting shall conform to Section 09 91 00, Painting.

3.5 FIELD QUALITY CONTROL

A. Testing, General:

1. Test all piping, except as exempted in the Exposed Piping Schedule.
2. Notification:
 - a. Notify ENGINEER at least 48 hours prior to testing.
 - b. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
3. Conduct all tests in presence of ENGINEER.
4. Remove or protect pipeline-mounted devices that could be damaged by testing.
5. Provide all apparatus and services required for testing, including:
 - a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.

6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.
8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or OWNER. Repair of existing piping will be paid as extra work unless otherwise specified.

B. Test Schedule:

1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.
2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Exposed Piping Schedule:
 - a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig.
4. Test Pressure:
 - a. Use test pressures listed in Exposed Piping Schedule.
 - b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:

1. Preparation for Testing:
 - a. For thermoplastic pipe and FRP pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
 - b. For other piping follow procedures described in AWWA Manual M9. A wetting period is not required for pipe that is not cement mortar-lined.
 - c. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
 - d. Piping for Hydraulic Fluid, Lube Oil, and Diesel Fuel: Hydrostatically test system using the fluid with which system will function permanently. Allowable leakage is zero. For fluid power systems, manufacturer shall supervise installation and testing of system components, including field piping.

2. Test Procedure:
 - a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.
 - b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
 - c. Examine joints and valves, and make repairs to eliminate visible leakage.
 - d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
 - e. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
 - f. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. The test pressure shall then remain steady for one hour, indicating no leakage.
 - g. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen minute intervals for duration of test.
3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:
 - a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.

3.6 EXPOSED PIPING SCHEDULE

- A. The schedules listed below, following the “End of Section” designation, are a part of this Specification section.
 1. Table 40 05 05-A, Exposed Piping Schedule.

+ + END OF SECTION + +

TABLE
40 05 05-A, EXPOSED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test
FD		PVC	--	--	SCH. 80	SW	--
FM	6 to 14	DI	CL	P	CL. 53	FL	HYD (100)
NG	2	CS	--	P	SCH 40	TH	IFGC
SP	2	PVC	--	--	SCH. 80	SW	HYD (60)

The following abbreviations are used in the Exposed Piping Schedule.

Service Abbreviations

Service	Abbrev.	Service	Abbrev.	Service	Abbrev.	Service	Abbrev.
Floor Door Drain	FD	Force Main	FM	Natural Gas	NG	Sump Pump Discharge	SP

Material Abbreviations

Material	Abbrev	Material	Abbrev.
Ductile Iron	DI	Polyvinyl Chloride	PVC

Lining/Coating Abbreviations

Lining	Abbrev	Coating	Abbrev
Cement Mortar Lined	CL	Painted	P

Joint Abbreviations

Joint Type	Abbrev	Joint Type	Abbrev	Joint Type	Abbrev.
Flanged	Flg	Solvent Weld	SW	Threaded	TH

Test Abbreviations

Test	Abbrev	Test	Abbrev
Hydrostatic Test (test pressure in psig)	HYD ()	International Fuel Gas Code	IFGC

SECTION 40 05 08

VALVES AND MISCELLANEOUS PIPING APPURTENANCES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all valves and miscellaneous piping appurtenances to complete the Work.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate with the installation of valves and miscellaneous piping appurtenances that must be installed with or within formwork, walls, partitions, ceilings and panels.
- C. Related Sections:
 - 1. Section 33 05 05, Buried Piping Installation.
 - 2. Section 40 05 05, Exposed Piping Installation.

1.2 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Detailed drawings and data on all wall and floor pipe, and pipe sleeves. Submit and coordinate these with Shop Drawings required for all piping systems.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Comply with the requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Valves:
 - 1. General:
 - a. Valve size and location: See Drawings.
 - b. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.

- c. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
 - 1) Valve size.
 - 2) Pressure and temperature ratings.
 - 3) Application (other than water and wastewater).
 - 4) Date of manufacture.
 - 5) Manufacturer's name.
 - d. Provide valves to turn clockwise to close, unless otherwise specified.
 - e. Provide valves with permanent markings for direction to open.
 - f. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.
2. Materials:
- a. Valve materials shall be suitable for the associated valve's service or application, as shown.
 - b. Protect wetted parts from galvanic corrosion caused by contact of different metals.
3. Valve Joints:
- a. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
 - b. Buried Valves: Unless otherwise specified, provide with mechanical or push-on joints, restrained or unrestrained, as required by piping with which valve is installed.
 - c. For stainless steel bolting, except where nitride nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

B. Eccentric Plug Valves:

- 1. Manufacturers: Provide products of one of the following:
 - a. DeZurik.
 - b. Or equal.
- 2. General:
 - a. Provide eccentric-type plug valves each with rectangular ports.
 - b. Minimum Rated Working Pressure:
 - 1) Valves 12-inch Diameter and Smaller: 175 psig.
 - c. Maximum Fluid Temperature: 180 degrees F.
 - d. Minimum Port Area:
 - 1) Valves 20-inch Diameter and Smaller: 100 percent of nominal pipe area.
 - e. Packing and packing gland shall be externally adjustable and accessible without disassembling valve and without removing the actuator.
 - f. Valves shall provide drip-tight, bi-directional shutoff at rated pressures.

- g. Plug shall have cylindrical seating surface eccentrically offset from center of plug shaft. Interface between plug face and body seat, with plug in closed position, shall be externally adjustable in the field with valve in the line while under pressure.
 - h. Plug shall be supported to top bearing by using spring that is externally adjustable.
- 3. Materials of Construction:
 - a. Body: Cast Iron ASTM A126 Class B, or Ductile-iron ASTM A536 Grade 65-45-12.
 - b. Plug:
 - 1) Core: Cast Iron ASTM A126 Class B, or Ductile-iron, ASTM A536 Grade 65-45-12.
 - 2) Plug Facing: Neoprene.
 - c. For valves up to eight-inch diameter, plugs shall be fully encapsulated with rubber. For valves larger than eight-inch diameter, provide plugs with rubber facing. Minimum thickness of rubber lining shall be 1/8-inch. Rubber hardness shall be a minimum of 70 (Shore A) durometer. Rubber-to-metal bond shall withstand minimum 75-pound pull conforming to ASTM D429 Method B.
- 4. Seats: Minimum 1/8-inch welded overlay of minimum 90 percent pure nickel on surfaces contacting plug face. Seats shall provide contact area of at least 1/2-inch width all around.
- 5. Stem Bearings: Sintered, oil impregnated, permanently lubricated of Type 316 stainless steel.
- 6. Stem Seal: Multiple neoprene V-ring type.
- 7. All internal and external bolting and other hardware including pins, set screws, plug, studs, bolts, nuts and washers shall be Type 316 stainless steel.
- 8. Interior Coating and Lining:
 - a. Valves shall be coated inside. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be epoxy-coated in accordance with AWWA C550.
- 9. Shop Testing:
 - a. Operational Tests:
 - 1) To demonstrate that complete assembly is workable, successfully operate each valve (with actuator mounted directly on valve) three times from fully closed to fully open position and reverse under no-flow condition.
 - b. Leakage Tests:
 - 1) Test each valve for leaks while valve is in closed position.
 - 2) Test valves at rated pressures. During test, valves shall be drip-tight. Test duration shall be at least five minutes for valves up to 20-inch diameter. Tests shall be repeated successfully with pressure in the unseating direction.

- c. Hydrostatic Test: Test valves to an internal hydrostatic pressure equivalent to twice rated pressure of valve. During hydrostatic test, there shall be no leakage through metal, end joints, and shaft seal, nor shall any part be permanently deformed. Duration of hydrostatic test shall be sufficient to allow visual examination for leakage. Test duration shall be at least one minute for valves eight-inch diameter and smaller, three minutes for valves 10-inch through 20-inch diameter.
10. Gear Actuators for Manually-operated Valves:
- a. Provide gear actuators on exposed valves, except valves four-inch diameter and smaller located less than five feet above operating floor shall have lever operator.
 - 1) Size gear actuators for valves eight-inch diameter and smaller for 175 psig differential pressure.
 - 2) Size gear actuators for valves larger than eight-inch diameter for the maximum differential pressures:
 - b. Provide actuators capable of holding associated valves in any intermediate position without creeping or vibrating.
 - c. Provide valve position indicator on each actuator. Provide stop-limiting devices for open and closed position. For buried and submerged service actuators, provide position indicators in valve box.
 - d. Provide adjustable stop to adjust seating pressure.
 - e. Make packing accessible for adjustment without requiring removal of actuator from valve, except for valves in buried and submerged service.
 - f. Provide each actuator with gearing totally enclosed.
 - g. Operator shaft and gear sector shall be supported on permanently lubricated bronze or stainless steel bearings.
 - h. Provide metal-encased spring loaded seals in top and bottom covers of gear housing.
 - i. Actuators shall be provided to produce indicated torque with maximum pull of 40 pounds on handwheel or chainwheel and maximum input of 150-foot pounds on operating nuts, for both seating and unseating heads equal to maximum differential pressure rating of valve.
 - j. Actuator components between input and stops shall be designed to withstand, without damage, a pull of 200 pounds for handwheel or chainwheel actuators and input torque of 300-foot pound for operating nuts when operating against stops.
 - k. Materials of Construction:
 - 1) Housing: Cast-iron, ASTM A126 Class B.
 - 2) Gear Sector: Cast-iron ASTM A126 Class B, or ductile iron ASTM A536.
 - 3) Bearings: Bronze oil-impregnated, or stainless steel.
 - 4) Hardware, including bolts, nuts, washers, set screws, and pins, shall be Type 316 stainless steel.

- C. Appurtenances for Exposed Metallic Valves: Where indicated, provide extension stems and floor boxes.
1. Extension Stems:
 - a. Materials of Stems and Stem Couplings: Type 316 stainless steel.
 - b. Maximum Slenderness Ratio (L/R): 100.
 - c. Minimum Diameter: 1.5-inch.
 - d. Threads: Acme.
 - e. Provide stem couplings where stems are furnished in more than one piece. Couplings shall be threaded and keyed or threaded and bolted and shall be of greater strength than the stem.
 - f. Weld to bottom of extension stem a Type 316 stainless steel cap suitable for square end of valve stem.
 2. Bottom Couplings: Ductile iron with Type 316 stainless steel pin and set screw.
 3. Stem Guides:
 - a. Material: Type 316 cast stainless steel with bronze bushing for stem.
 - b. Maximum Stem Length Between Guides: Seven feet.
 - c. Stem guides shall be adjustable in two directions.
 4. Floor Boxes: Provide cast-iron floor boxes for valves that are to be operated from floor above valve. Boxes shall be equal in depth to floor slab. Boxes shall have cast-iron covers and be fitted with bronze bushing.
- D. Appurtenances for Buried Metallic Valves
1. Extension Stems for Quarter-turn Buried Valves:
 - a. Provide extension stems to bring operating nut to six inches below valve box cover.
 - b. Materials of Stems and Stem Couplings: Type 316 stainless steel.
 - c. Maximum Slenderness Ratio (L/R): 100
- E. Combination Air Valve Assemblies:
1. Includes a 2 inch combination air valve screw connected into the forcemain via a new tapped plug on the existing tee fitting, as shown on the Drawings. A ball valve shall be installed at the base of the assembly to provide proper isolation. The assembly shall be equipped with the required lengths of pipe and fittings so as to permit use without entering manhole.
 - a. Combination Air Valve: 2 inch, MIPT inlet; Stainless Steel body.
 - 1) Products and Manufacturers: Provide one of the following:
 - a) D-26 2", threaded, as manufactured by A.R.I.
 - b) Or equal.
 - 2) Manufacturer shall provide air valves with low pressure seals for locations susceptible to low pressure conditions. Combination Air Valve Locations 1 and 3, as identified on the Drawings, shall be installed with low pressure seals.
 - b. Connection: Screw-type; tapped plug.
 - c. Ball valve: 2 inch, Stainless Steel.
 - d. Pipe and Fittings: Stainless Steel; lengths to allow operating without entering manhole.

- F. Wall and Floor Pipes:
1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by ENGINEER.
 2. End Connections: As shown.
 3. Thickness: Same as specified for the piping connected to wall or floor pipe.
 4. Collars: Provide collars at mid-point of wall for anchorage and watertightness.
 5. Pipes ends shall be flush with wall face, unless otherwise shown.
 6. Drill and tap flanged ends and mechanical joint bells for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of Type 316 stainless steel.
- G. Pipe Sleeves:
1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown.
 2. Copper Pipe: Use Type K hard drawn copper pipe, unless otherwise shown.
- H. Cast Wall Sleeves:
1. Material: Ductile iron furnished with integral wall collar.
 2. Dimensions: As required for mechanical joint pipe to pass through sleeve. Length as required.
- I. Mechanical Seals: Provide link type mechanical seals suitable for 20 psi working pressure, corrosive service and accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
1. Products and Manufacturers: Provide one of the following:
 - a. Link-Seal, as manufactured by Thunderline Corporation.
 - b. Or equal.
- J. Sleeve-type, Flexible Couplings:
1. Pressure and Service: Same as connected piping.
 2. Products and Manufacturers: Provide products of one of the following:
 - a. Style 253, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
 - b. Style 441, by Smith Blair, Inc.
 - c. Or equal.
 3. Material: Ductile Iron.
 4. Gaskets: Suitable for specified service, as recommended by manufacturer.
 5. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated. For buried or submerged applications, provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.

6. Harnessing:
 - a. Harness couplings to restrain pressure piping. For pipelines that will be under pressure, test pressures are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - b. Tie adjacent flanges with bolts of corrosion-resistant alloy steel. Provide flange-mounted stretcher bolt plates to be designed by manufacturer, unless otherwise approved. For buried or submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers.
 - c. On plain-end piping, for harnessing couplings, provide anchor restraint system such as Dresser Piping Specialties STAR Anchor Style 443, or equal.
 - d. Conform to dimensions, size, spacing, and materials for lugs, bolts, washers, and nuts as recommended by manufacturer and approved by ENGINEER for pipe size, wall thickness, and test pressure required. Provide minimum 5/8-inch diameter bolts.

K. Quick Connect Couplings:

1. Type: Cam-and-groove.
2. Size: as indicated.
3. Materials: Stainless steel with Buna-N gaskets.
4. Products and Manufacturers: Provide one of the following:
 - a. Dover Corp./OPW Division, Kamlok Series.
 - b. PT Coupling Company, Inc., Basic Standard Cam and Groove Couplings.
 - c. Or as approved.

2.2 PAINTING OF BURIED VALVES AND VALVES IN BURIED STRUCTURES

- A. Exterior steel, cast-iron, and ductile iron surfaces, except machined or bearing surfaces of buried valves, including valves to be located in buried structures shall be painted in valve manufacturer's shop with two coats of asphalt varnish conforming to FS TT-C 494.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.
- B. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Install valves and appurtenances in accordance with:
 - a. Supplier's instructions and the Contract Documents.
 - b. Requirements of applicable AWWA standards.
 - c. Applicable requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.

B. Exposed Valves:

1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
2. Operators:
 - a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
 - b. Avoid placing operators at angles to floors or walls.
 - c. Install valves so that indicator arrows are visible from floor level.
3. Valve Boxes and Stems for valves installed in Vaults:
 - a. Install valve boxes in top slab as shown and as recommended by manufacturer.
 - b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.

C. Buried Valves:

1. Install valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of box, or to undisturbed trench face if less than four feet.
2. Provide flexible coupling next to each buried valve.

D. Plug Valves:

1. Install plug valves that are in horizontal liquid piping with stem horizontal and plugs on top when valve is open. Plug shall be on upstream end when valve is closed.
2. Supplier shall tag or mark plug valves to indicate proper mounting position.

E. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings.

F. Pipe Sleeves:

1. Use sleeves wherever pipes pass through walls, partitions, floors, and roofs, unless otherwise shown.
2. Extend all sleeves through floor slabs a minimum of 2-inches above finished floor.

3. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
4. All sleeves through walls shall be flush with wall face.
5. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
6. Use link type seals to seal sleeve against hydrostatic pressure. Size sleeves to provide annular space required to suit the link type mechanical seals that are used.
7. Do not install sleeves and pipes through structural members, unless specifically shown and approved by ENGINEER.
8. Size sleeves to provide annular space as follows:

<u>Pipe Size</u>	<u>Sleeve ID Minus Pipe Or Insulation OD</u>
Less than 2-inches	1/2-inches to 3/4-inches
2-inches to 4-inches	3/4 inches to 1-1/4-inches.
6-inches to 12-inches	1-1/4 inches to 2-inches
Over 12-inches	2-inches to 3-inches

3.3 FIELD QUALITY CONTROL

A. Field Tests:

1. Adjust all parts and components as required to provide correct operation of valves.
2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
3. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.

+ + END OF SECTION + +

SECTION 40 05 19

DUCTILE IRON PROCESS PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
2. Extent of piping is shown on the Drawings. Piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:

1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.
2. Notify other contractors in advance of installation of ductile iron pipe to provide other contractors with sufficient time to install items included in their contracts that will be installed with or before ductile iron pipe Work.

C. Related Sections:

1. Section 09 91 00, Painting.
2. Section 33 05 05, Buried Piping Installation.
3. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:

1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
6. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
7. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
8. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
9. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
10. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
11. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.

12. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
13. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
14. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.

1.3 ADDITIONAL WORK ITEMS

- A. Item A.6 – Additional Buried, Class 53, Cement Lined, Ductile Iron, Restrained Mechanical Joint, Force Main Piping, having nominal diameters noted below: Provide under the provisions of Section 01 22 13, Measurement and Payment.
 1. Item A.6.1 - 6-inch.
 2. Item A.6.2 – 8 inch.
 3. Item A.6.3 - 10 inch.
 4. Item A.6.4 - 12 inch.
 5. Item A.6.5 - 16 inch.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 1. Manufacturer:
 - a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
 - b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines exposed to the specified service conditions , and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
 - c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.
- B. Supply and Compatibility:
 1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
 2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
 3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
 4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following with Shop Drawings required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation:
 - 1. Shop Drawings:
 - a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.
- B. Informational Submittals: Submit the following:
 - 1. Certificates:
 - a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
 - 2. Source Quality Control Submittals:
 - a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
 - b. Lining and coating test coupons.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General:
 - 1. Piping systems shall be suitable for their intended use.
 - 2. Joints shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.
- B. Ductile Iron Pipe, Joints, and Fittings:
 - 1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
 - a. Pressure Rating: As specified in piping schedule in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 54-inch diameter pipe.
 - 2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
 - a. Pressure Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 54-inch diameter pipe and Pressure Class 350 for 60-inch and 64-inch diameter pipe.

- b. Special Thickness Class: As specified in piping schedules in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation.
- 3. Pipe Joints:
 - a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 40 05 05, Exposed Piping Installation.
 - 1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.
 - 2) Bolts: Comply with ANSI B18.2.1.
 - a) Exposed: ASTM A307, Grade B.
 - b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
 - 3) Nuts: Comply with ANSI B18.2.2.
 - a) Exposed: ASTM A563, Grade A, Heavy hex.
 - b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.
 - b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 - 1) Glands: Ductile iron.
 - 2) Gaskets: Plain tip.
 - 3) Bolts and Nuts: High strength, low alloy steel.
 - 4) Manufacturers: Provide products of one of the following:
 - a) Clow Water Systems Company
 - b) Atlantic States Cast Iron Pipe Company
 - c) Canada Pipe Company, Ltd.
 - d) McWane Cast Iron Pipe Company
 - e) Pacific States Cast Iron Pipe Company
 - f) Griffin Pipe Products Co.
 - g) American Cast Iron Pipe Co.
 - h) U.S. Pipe and Foundry Co.
 - i) Or equal.
 - c. Restrained Joints: Restrained joints shall be capable of being deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of ENGINEER.
 - 1) Products and Manufacturers: Provide restrained joints for mechanical joint piping by one of the following:
 - a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
 - b) MJ Coupled Joint, by American Cast Iron Pipe Co.
 - c) MJ Field Lok, by U.S. Pipe and Foundry Co.

- d) Or equal.
- 4. Flanged Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.
- 5. Mechanical Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.
 - a. Material: Ductile iron.
 - ~~b.~~ Glands: Ductile iron.
 - c. Pressure rating, gaskets, bolts, and nuts shall be as specified for mechanical joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of connected pipe.
- C. Cement-mortar Lining:
 - 1. Where specified in piping schedules included with Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation, pipe and fittings shall be lined with bituminous seal coated cement-mortar lining in accordance with ANSI/AWWA C104.
- D. Specials:
 - 1. Transition Pieces:
 - a. Provide suitable transition pieces (adapters) for connecting to existing piping.
 - b. Unless otherwise shown or indicated, expose existing piping to determine material, dimensions, and other data required for transition pieces.
 - 2. Taps:
 - a. Provide taps where shown or required for small-diameter piping or instrumentation connections.
 - b. Provide corporation stops where shown or required.
 - c. Where pipe wall thickness or tap diameter will not allow engagement of threads, provide tapping saddle with outlet joints conforming to requirements of Paragraph 2.1.B.3.a of this Section for four-inch through 12-inch diameter pipe, and Paragraph 2.1.B.3.b. for 14-inch through 54-inch diameter pipe.
 - d. For flanged connections on tapping saddle outlet branch, counterbore flange in accordance with MSS SP-60 dimensions. Inside diameter of outlet shall be 1/4-inch greater than nominal diameter.

2.2 MARKING FOR IDENTIFICATION

- A. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
 - 1. Name or trademark of manufacturer.
 - 2. Weight, class or nominal thickness, and casting period.
 - 3. Country where cast.
 - 4. Year the pipe was produced.

5. Letters “DI” or “Ductile” shall be cast or metal stamped
- B. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
 1. Flange manufacturer’s mark, size, and letters “DI” cast or stamped on the flanges.
 2. Fabricator’s mark if other than flange manufacturer.
 3. Length and weight.
- C. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify fittings with:
 1. Manufacturer’s identification.
 2. Pressure rating.
 3. Nominal diameters of openings.
 4. Country where cast.
 5. Number of degrees or fraction of the circle on bends.
 6. Letters “DI” or “Ductile” cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

- A. General Coating Requirements:
 1. Coating types are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
- B. Exposed Pipe and Fittings:
 1. Surface Preparation:
 - a. Initial Surface Inspection: Pipe and fitting manufacturer and coating applicator shall inspect surface to be coated and mutually determine recommended NAPF 500-03 surface preparation method.
 - b. Surface Preparation: Prepare surface in accordance with recommended NAPF 500-03 method.
 - c. Finished Surface Inspection: Prepared surfaces shall be inspected by coating applicator prior to application to determine acceptability of finished surface. If surface is unacceptable, repeat surface preparation and re-application as necessary.
 2. After recommended surface preparation, prime coat exterior ferrous metal surfaces of pipe and fittings in the shop in accordance with Section 09 91 00, Painting.
 3. Field painting shall comply with Section 09 91 00, Painting.
- ⊖ Buried Pipe and Fittings: (Including piping within Wet Wells and other Buried Structures)
 1. Asphaltic Coating: Where specified in piping schedule in Section 33 05 05, Buried Piping Installation, coat pipe and fittings with an asphaltic coating approximately one-mil thick, in accordance with ANSI/AWWA C151, ANSI/AWWA C115, ANSI/AWWA C110, and ANSI/AWWA C153, as applicable.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

- A. For buried piping installation and testing, refer to Section 33 05 05, Buried Piping Installation.
- B. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 24.13

STEEL PIPE FOR GAS SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install steel pipe, fittings, and accessories for air and gas service.
 - 2. Extent of pipe, fittings and accessories is shown on the Drawings and indicated in the exposed piping schedule included in Section 40 05 05, Exposed Piping Installation.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before steel pipe, fittings, and accessories for low-pressure air service Work.
- C. Related Sections:
 - 1. Section 09 91 00, Painting.
 - 2. Section 33 05 05, Buried Piping Installation.
 - 3. Section 40 05 05, Exposed Piping Installation.
 - 4. Section 40 05 06, Couplings, Adapters, and Specialties for Process Piping.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/AWS D1.1, Structural Welding Code – Steel.
 - 2. ANSI B16.3, Malleable Iron Threaded Fittings.
 - 3. ANSI B16.5, Pipe Flanges and Flanged Fittings.
 - 4. ANSI B16.11, Forged Steel Fittings, Socket-Welding and Threaded.
 - 5. ASME Boiler and Pressure Vessel Code, Section V: Nondestructive Examination.
 - 6. ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications.
 - 7. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification and Certification in Non-destructive Testing.
 - 8. ASTM A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - 9. ASTM A105, Standard Specification for Carbon Steel Forgings for Pipe Applications.

10. ASTM A234, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
11. AWS B2.1, Standard WPS for Gas Tungsten Arc Welding with Consumable Inserts of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), 1/8 through 1 1/2" Thick, INMs-1 and ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Applications.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer:
 - a. Manufacturers shall have minimum of five years experience producing steel pipe, fittings, expansion joints, couplings, and accessories for air and gas service, and shall submit upon request documentation of at least five installations in satisfactory service for at least five years.
2. Welding:
 - a. Shop welding and field welding (where allowed by ENGINEER) of steel pipe and components shall be by certified welders, each having valid certificates conforming to the ASME Boiler and Pressure Vessel Code, demonstrating qualifications under Section IX, or AWS B2.1.
 - b. Personnel performing examination of welds shall be qualified to at least Level II, in accordance with ASNT-TC-1A.
3. Weld Inspectors:
 - a. Inspection of shop welds and field welds (where allowed by ENGINEER) of steel pipe and components shall be by certified weld inspectors, each having valid certificates conforming to ASME Boiler and Pressure Vessel Code Section V, or ANSI/AWS D1.1, as applicable for type of inspection required.

B. Component Supply and Compatibility:

1. Unless otherwise approved by ENGINEER, obtain all materials equipment included in this Section, regardless of component manufacturer, from single steel pipe, fittings and accessories Supplier.
2. Supplier of steel pipe, fittings, and accessories for air and gas service shall review and approve, or prepare, all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for specified service conditions and shall be integrated into overall assembly by steel pipe, fittings, and accessories Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings: Submit the following with submittals required under Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation:
 - a. Detailed drawings and data for pipe, fittings, joint types, gaskets, and appurtenances.

- b. Laying schedules and detailed plan and profile drawings for all steel piping showing full details of piping, valve locations, hangers, supports, restraints, couplings, accessories and specials.
 - c. Written welding procedures for each type of weld and weld position.
 - 2. Product Data:
 - a. Manufacturer's literature, including materials of construction, dimensions, weights, specifications and other engineering data.
 - 3. Testing Procedures: Quality control, inspection and testing procedures.
- B. Informational Submittals: Submit the following:
- 1. Certificates.
 - a. Certificates of compliance with applicable portions of standards referred to in this Section.
 - 2. Design Data Not Signed and Sealed by a Design Professional:
 - a. Steel Pipe and Fittings:
 - 1) Verification of strength of pipe joints within spans between pipe supports.
 - 3. Supplier Instructions:
 - a. Installation data and instructions.
 - 4. Source Quality Control Submittals:
 - a. Pipe and fittings shop tests, including weld examination, product inspection, and test reports, in accordance with Article 2.5 of this Section.
 - b. Results of source quality control examinations, tests, and inspections for expansion joints, couplings, and appurtenances.
 - c. ASTM Conformance Test Reports: For pipe and fittings manufactured outside of the United States, submit test and inspection reports verifying certification with ASTM standards referenced in this Section.
 - 5. Qualifications Statements:
 - a. Pipe Manufacturer: When requested by ENGINEER, submit list of existing installations with contact names and telephone numbers for each.
 - b. Welders: Submit qualifications for automatic and manual welding operators and procedures to demonstrate conformance to specified qualification requirements.
 - c. Weld Inspectors: For each, submit certified weld inspector's QC-1 certification and qualifications.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
- B. Handling:
 - 1. Handling of Pipe: To maintain circular shape and prevent distortion, temporarily brace each end of each length of pipe with pipe manufacturer-approved internal spider device, where recommended by pipe manufacturer.

2. Handling of Steel Fabrications during Manufacturing, at the Site, and Elsewhere:
 - a. Use tools dedicated for steel.
 - b. Use nylon slings and alloy chains, cable, or straps for handling steel.
 - c. Use storage racks of non-ferrous metal or lined with rubber for storing steel pipe, fittings, and accessories.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. General:
 1. Piping systems and components shall conform to the Contract Documents and be suitable for their intended use.
 2. Joint types, linings, and coatings shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and welded joints for buried piping.
- B. ASTM Conformance:
 1. Pipe and fittings shall conform to ASTM standards referenced in this Section. For pipe and fittings manufactured outside of the United States, physical tests and chemical analyses shall be performed as required on pipe and fittings being furnished to verify ASTM conformance. Tests and analyses shall be performed by an independent testing agency approved by ENGINEER and paid by CONTRACTOR. Select test samples in conformance with ASTM requirements.

2.2 GAS PIPING

- A. Exposed Service:
 1. Pipe: ASTM A53, Schedule 40 black.
 2. Fittings: ANSI B16.3, malleable iron, ANSI B16.11, forged steel, or ASTM A234 Grade WPB, forged steel welding type.
 3. Joints:
 - a. Pipe Sizes 2-1/2 inches and less: All exposed joints threaded.
 - b. Pipe Sizes over 2-1/2 inches: All exposed joints welded.
 4. Flanges: Carbon Steel, 150 pounds, with appropriate facings and gaskets for mating with valves and equipment; ASTM A105; ANSI B16.5.

2.3 IDENTIFICATION

- A. All pipeline materials shall be stamped, marked, or identified on interior and exterior with the following:
 1. Manufacturer's name or trademark.
 2. Pipe class and reference standard designation.
 3. Size and length dimensions.
 4. Date and place of manufacture.

2.4 SOURCE QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Inspections: All pipe and fittings, shop applied linings and coatings, shop welds, and related Work performed in the shop shall be inspected by manufacturer in accordance with applicable reference standards and as specified in this Section. Submit inspection reports to ENGINEER prior to shipment from the shop.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which stainless steel pipe, fittings, and accessories for low-pressure air Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Conform to installation requirements specified in Section 40 05 05, Exposed Piping Installation.
- B. Use anti-seize compound for stainless steel nuts and bolts to prevent galling.
- C. Conform to manufacturer's recommendations for installing expansion joints and couplings.
- D. Provide harnessing rods on expansion joints and couplings where shown or indicated.
- E. After installation of steel piping, wash foreign matter from piping surfaces with detergent and hot water followed by rinse cleaning.
- F. Field-welded joints shall conform to requirements for shop-welded joints specified in this Section.
- G. Repairs to coatings shall be made as recommended by the manufacturer of pipe and coating, and as accepted by ENGINEER.

3.3 FIELD QUALITY CONTROL

- A. Comply with Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 31

THERMOPLASTIC PROCESS PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install thermoplastic piping and fittings.
 - 2. Extent of piping is shown and shall be in accordance with piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before thermoplastic piping Work.
- C. Related Sections:
 - 1. Section 33 05 05, Buried Piping Installation.
 - 2. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

- A. Standards referenced in this Section are:
 - 1. AASHTO, Standard Specifications for Highway Bridges.
 - 2. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
 - 3. ASTM D1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
 - 4. ASTM D2467, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 - 5. ASTM D2564, Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
 - 6. ASTM F656, Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
 - 7. NSF 14, Plastic Piping Systems Components and Related Material.

1.3 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Manufacturer: Shall have a minimum of five years experience producing thermoplastic pipe and fittings substantively similar to the materials specified, and shall be able to submit documentation of satisfactory service in at least five completed installations in operation for at least five years each.

2. Installer:
 - a. Engage a single pipe installer who shall be responsible for all thermoplastic pipe Work, and who shall employ only tradesmen with specific skills and experience in the type of Work required.
 - b. Installer shall have a minimum of five years experience installing thermoplastic pipe and fittings substantively similar to the materials specified and substantively similar to or larger than the scope of thermoplastic piping Work on the Project, and shall be able to submit documentation of satisfactory experience in at least five completed installations in operation for at least five years each.
- B. Component Supply and Compatibility:
 1. Obtain all materials included in this Section, regardless of component Supplier, from a single thermoplastic pipe Supplier. All pipe of each material type shall be furnished by the same manufacturer.
 2. Thermoplastic pipe Supplier shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
 3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by thermoplastic pipe Supplier.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 1. Shop Drawings:
 - a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
 2. Product Data:
 - a. Submit product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.
- B. Informational Submittals: Submit the following:
 1. Certificates:
 - a. Submit manufacturer's certificate of compliance standards referenced in this Section.
 2. Source Quality Control Submittals:
 - a. When requested by ENGINEER, submit results of source quality control tests.
 3. Qualifications Statements:
 - a. Submit qualifications of manufacturer when requested by ENGINEER.
 - b. Submit qualifications of installer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. General:

1. Pipe materials shall be suitable for services intended. Refer to piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
2. Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, and other defects. Unless otherwise shown or indicated, pipe shall be uniform in color, opacity, density, and other physical properties.
3. Comply with NSF 14.
4. Buried pipe shall be capable of withstanding external live load, including impact, equal to AASHTO H-20 loading, with cover shown or indicated on the Drawings.

2.2 POLYVINYL CHLORIDE (PVC) PIPING

A. PVC Pipe – General Applications: Unless otherwise shown or indicated, PVC pipe shall comply with the following:

1. Manufacturers: Provide products of one of the following:
 - a. Ipex, Inc.
 - b. Spears Manufacturing Company.
 - c. Or equal.
2. Material: Unless otherwise specified, comply with the following:
 - a. Type and Grade: Type 1, Grade 1.
 - b. Wall Thickness: Schedule 80 complying with ASTM D1784 and ASTM D1785, and US Product Service PS 21-70 as having same outside diameter dimension as cast-iron pipe.
 - c. Temperature Rating: Rated for temperature to 140 degrees F.
 - d. Color: Gray.
3. Fittings: Type, grade, schedule, and color of fitting shall match the associated pipe.
 - a. Solvent Weld: Comply with ASTM D2467.
4. Joints:
 - a. Solvent Weld: Use primer and solvent cement recommended by PVC pipe manufacturer for the application. Primer shall be in accordance with ASTM F656, and solvent cement shall be in accordance with ASTM D2564.

2.3

2.3 IDENTIFICATION

- #### A. Pipe material identification requirements are in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

2.4 SOURCE QUALITY CONTROL

- A. Shop Tests:
 - 1. Pipe manufacturer shall maintain continuous quality control program.
 - 2. Where applicable and when requested by ENGINEER, submit results of source quality control tests specified in reference standards.
 - 3. CPVC plastic molding materials used for manufacturing pipe and fittings under this Section shall be tested for compliance with ASTM D1784.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

- A. For buried piping installation, refer to Section 33 05 05, Buried Piping Installation.
- B. For exposed piping installation, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 33

HIGH DENSITY POLYETHYLENE PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, test, and place in satisfactory service the High Density Polyethylene (HDPE) process pipe and fittings as shown.
 - 2. The extent of HDPE pipe and fittings to be furnished is shown and in the piping schedules included in Section 33 05 05, Buried Piping Installation.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with, or before, the HDPE process pipe Work.
- C. Related Sections:
 - 1. Section 33 05 05, Buried Piping Installation.

1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
 - 1. American Society for Testing and Materials, Inc., (ASTM).
 - a. ASTM D 638, Test Method for Tensile Properties of Plastics.
 - b. ASTM D 746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - c. ASTM D 790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - d. ASTM D 1238, Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
 - e. ASTM D 1505, Test Method for Density of Plastics by the Density-Gradient Technique.
 - f. ASTM D 1598, Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure.
 - g. ASTM D 1599, Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings.
 - h. ASTM D 1603, Test Method for Carbon Black in Olefin Plastics.
 - i. ASTM D 2240, Test Method for Rubber Property-Durometer Hardness.
 - j. ASTM D 2290, Test Method for Apparent Hoop Tensile Strength of Plastic Reinforced Plastic Pipe by Split Disk Method.

- k. ASTM D 2412, Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- l. ASTM D 2513, Specification for Polyethylene Gas Pressure Pipe, Tubing and Fittings.
- m. ASTM D 2837, Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- n. ASTM D 3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
- o. ASTM D 3350, Specification for Polyethylene Plastics Pipe and Fittings Materials.
- p. ASTM F 714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
- q. ASTM F 1248, Test Method for Determination of Environmental Stress Crack Resistance (ESCR) of Polyethylene Pipe.
- 2. American Water Works Association, (AWWA).
 - a. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4-inch through 63-inch, for Water Distribution.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

- 1. Manufacturer shall have a minimum of five years experience producing substantial similar type materials and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
- 2. HDPE process pipe and fittings shall be the product of a single manufacturer.
- 3. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance Program responsible for inspecting incoming and outgoing materials.
- 4. The HDPE process pipe and fittings manufacturer shall have an established Quality Assurance program responsible for assuring the long-term performance of materials and products.
- 5. The HDPE process pipe and fitting manufacturer shall maintain permanent Quality Assurance/Quality Control (QA/QC) records.

B. Installer's Qualifications:

- 1. Engage a single installer regularly engaged in HDPE process piping installation and with experience in the installation of the types of materials required; and who agrees to employ only tradesmen with specific skill and experience in this type of Work. Submit name and qualifications to ENGINEER.
- 2. Engage a single installer for the entire HDPE process piping system with undivided responsibility for performance and other requirements.

- C. Component Supply and Compatibility:
 - 1. The HDPE process pipe and fittings manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
 - 2. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the HDPE process pipe and fittings manufacturer.

1.4 SUBMITTALS

- A. Submit these with Shop Drawings required under Section 33 05 05, Buried Piping Installation.
- B. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Details of piping system including location of supports, restraints, fittings, anchors, vents, low-point drains, termination assemblies and all accessories necessary for piping system.
 - b. Pipe laying schedules.
 - 2. Product Data:
 - a. Details of construction, fabrication, and pipe materials.
 - b. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.
 - 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Pipe testing procedures.
- C. Informational Submittals:
 - 1. Certificates:
 - a. Materials Certificates of Conformance: Submit certificates of conformance with Referenced Standards as required in Article 2.4, below.
 - b. Upon shipment, CONTRACTOR shall furnish the HDPE pipe manufacturer's Quality Assurance/Quality Control (QA/QC) certifications to verify that the materials supplied for the Project are in accordance with the requirements of this Section and a manufacturer's warranty covering materials and workmanship of the HDPE piping.
 - 2. Suppliers Instructions:
 - a. Detailed procedures to be used in joining and installing piping system, including manufacturer's recommendations.
 - 3. Qualifications Statements:
 - a. Installer's qualifications.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Comply with applicable requirements of Section 33 05 05, Buried Piping Installation.

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. HDPE piping system shall be specifically designed, constructed, and installed for the service intended and shall comply with the following service conditions.

1. Gas pipe shall meet the requirements of ASTM D 2513.

- B. Physical Properties:

1. Materials used for the manufacture of polyethylene pipe and fittings shall meet the following physical property requirements:

Property	Unit	Test Procedure	Value
Material Designation	-	PPI TR-4	PE4710
Cell Classification	-	ASTM D 3350	445574C
Density	g/cm ³	ASTM D 1505	>0.95
Melt Index (E)	g/10 min	ASTM D 1238	<0.15
Flexural Modulus	psi	ASTM D 790	>110,000
Tensile Strength	psi	ASTM D 638	>3,500
PENT	hours	ASTM F 1473	>500
HDB	psi	ASTM D 2837	1,600 @ 23°C 1,000 @ 60°C
UV Stabilizer (C)	% carbon black	ASTM D 1603	2 to 3
Brittleness Temperature	F	ASTM D 746	<-100
Hardness Shore D		ASTM D 2240	>60
Molecular Weight Category	-	-	Extra-High

2. There shall be no evidence of splitting, cracking or breaking when the pipe is tested in accordance with Article 2.2, below.
3. Ring Stiffness Constant (RSC) values for the pipe can be directly related to the pipe's class designation. (Nominal RSC of Class 40 pipe = 40, etc.). The minimum RSC is 90 percent of the nominal.
4. The HDPE pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.
5. Clean rework or recycled material generated by the manufacturer's own production may be used as long as the pipe or fittings produced meet all the requirements of this Section.

- C. Dimensions:

1. Pipe Dimensions:
 - a. The nominal inside diameter of the gas pipe shall be true to the specified pipe size in accordance with ASTM D2513. Standard laying lengths shall be 40 feet ± 2-inches.
2. Fitting Dimensions: Fittings such as couplings, wyes, tees, adapters, etc. for use in laying pipe shall have standard dimensions that conform to ASTM D 3261.

- D. Pipe and fittings shall be produced from identical materials, meeting the requirements of this Section, by the same manufacturer. Special or custom fittings may be exempted from this requirement.
- E. Pipe and fittings shall be pressure rated to meet the service pressure requirements specified by ENGINEER. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.
- F. Molded fittings shall meet the requirements of ASTM D 3261 and this Section. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the diameter and wall thickness specifications of the mating system pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. The manufacturer shall provide an explanation of the production codes used.
- G. Marking:
 - 1. Each standard and random length of pipe and fitting in compliance with this standard shall be clearly marked with the following information.
 - a. ASTM or AWWA Standard Designation.
 - b. Pipe Size.
 - c. Class and Profile Number.
 - d. Production Code.
 - e. Standard Dimension Ratio (SDR).

2.2 SOURCE QUALITY CONTROL

- A. At a minimum, incoming polyethylene materials shall be inspected for density in accordance with ASTM D 1505 and melt flow rate in accordance with ASTM D 1238. All incoming polyethylene materials shall be certified by the supplier. Certification shall be verified by CONTRACTOR and ENGINEER. Incoming materials shall be approved by Manufacturer's Quality Assurance Program before processing into finished goods.
- B. Representative samples of polyethylene materials shall be tested against the physical property requirements required herein. Each extrusion line and molding machine shall be qualified to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D 1598.

C. Quality Assurance test for representative pipe and fitting samples shall include:

Test	Standard	Pipe	Fittings
Ring ESCR	ASTM F 1248	Yes	Not Applicable
Sustained pressure at 176°F/725 psi hoop stress: (f ₀ >100 h)	ASTM D 1598	Yes	Yes
Sustained pressure at 73°F/1,600 psi hoop stress: (f ₀ >1000 h)	ASTM D 1598	Yes	Yes

D. The HDPE pipe and fitting manufacturer shall certify that samples of their production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D 2837 and PPI TR-3. Under these procedures, the minimum hydrostatic design basis shall be certified by the pipe and fitting manufacturer to be 1,600 psi at 73.4°F and 800 psi at 140°F.

E. Material shall be listed in the name of the HDPE pipe and fitting manufacturer as required by the Plastics Pipe Institute (PPI) in PPI TR-4 with the following Standard Grade ratings:

	73.4°F	140°F
1. Hydrostatic Design Basis (HDB)	1,600 psi	1000 psi
2. Hydrostatic Design Stress (HDS)	800 psi	400 psi
3. PPI material listing in the name of the resin supplier is not acceptable in meeting this requirement.		

F. Inspection Requirements:

1. Notification: The HDPE pipe and fitting manufacturer shall notify CONTRACTOR in advance of the date, time, and place of testing of the pipe in order that CONTRACTOR may be represented at the test.
2. Access: The OWNER'S representative shall have free access to the Inspection area of the manufacturer's plant. The manufacturer shall make available to the OWNER'S representative, without charge, all reasonable facilities for determining whether the pipe meets the requirements of this Section.
3. Certification: As the basis of the acceptance of the material, the manufacturer will furnish a certificate of conformance of these Specifications upon request. When prior agreement is being made in writing between ENGINEER, CONTRACTOR and the manufacturer, the manufacturer will furnish other conformance certification in the form of affidavit of conformance, test results, or copies of test reports.
4. All outgoing materials shall be inspected for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut. Manufacturer's Quality Control Program shall perform tests of density, melt flow rate, carbon content, and carbon dispersion. In addition, samples of the pipe provided shall be tested for hoop tensile strength and ductility by either quick burst in accordance with ASTM D 1599 or ring tensile strength in accordance with ASTM D 2290. Molded fittings shall be subject to x-ray inspection for voids, and tests for knit line strength. All fabricated fittings shall be inspected for fusion quality and alignment.

G. Physical Test Requirements:

1. Sampling: The selection of the sample of pipe shall be as agreed upon by the ENGINEER, CONTRACTOR and the manufacturer. In case of no prior agreement, any sample selected by the manufacturer shall be deemed adequate.
2. Sample size for flattening test will be one sample for each size and class of pipe for the Project.
3. Conditioning: Conditioning of samples prior to and during test shall be as agreed upon by the ENGINEER, CONTRACTOR and manufacturer. In case of no prior agreement, the conditioning procedure used by the manufacturer shall be deemed adequate.

H. Test Methods:

1. Flattening: Three specimens of pipe, a minimum of 12-inches long, shall be flattened between parallel plates in a suitable press until the distance between the plates is 40 percent of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is completed within two to five minutes. Remove the load, and examine the specimens for splitting cracking or breaking.
2. Pipe Ring Stiffness Constant: The pipe ring stiffness constant shall be determined utilizing procedures similar to those outlined in ASTM D 2412. The stiffness of HDPE pipe is defined in terms of the load, applied between parallel plates, which causes one percent reduction of pipe diameter. Test specimens shall be a minimum of two pipe diameters or four feet in length, whichever is less.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 33 05 05, Buried Piping Installation.

B. Heat Fusion of Pipe:

1. HDPE pipe and fittings joints shall be heat fused by a qualified technician; trained by the manufacturer's representative in accordance with the manufacturer's recommended fusion procedures. Training must have occurred within the previous 12 months, or submittals verifying experience within the previous 12 months for all technicians performing heat fusion on polyethylene pipe and fittings.
2. Weld in accordance with manufacturer's recommendation for butt fusion methods. Personnel operating fusion equipment shall be certified by the HDPE pipe manufacturer.
3. The first butt fusion weld of each day's production welding and for each separate operator shall be tested by bent strap test method. No production welds shall be performed until successful completion of bent strap test.

4. Butt fusion equipment for joining procedures shall be capable of meeting conditions recommended by HDPE pipe manufacturer including, but not limited to, temperature requirements, alignment, and fusion pressures. The equipment used for the heat fusion joints shall be capable of recording the heating and fusion pressures used to join the HDPE pipe, recording heater temperature, and storing this information for future retrieval (data logger). Each field fusion shall be recorded by such equipment and this information shall be made compiled into daily log reports. Log reports shall be submitted to CONTRACTOR and ENGINEER daily. Reports shall also include the results of the bent strap tests.
5. For cleaning pipe ends, solutions such as detergents and solvents, when required, shall be used in accordance with manufacturer's recommendations.
6. Do not bend pipe to greater degree than minimum radius recommended by manufacturer for type and grade. Shop Drawings shall address locations and deflections of required fittings to prevent installation that exceeds a greater degree of bending than the manufacturer's recommended minimum bending radius for each size and class of HDPE pipe.
7. Do not subject pipe to strains that will overstress or buckle piping or impose excessive stress on joints.
8. Branch saddle fusions shall be joined in accordance with manufacturer's recommendations and procedures. Branch saddle fusion equipment shall be of size to facilitate saddle fusion within trench.
9. Before butt fusing pipe, inspect each length for presence of dirt, sand, mud, shavings, and other debris or animals. Remove debris from pipe.
10. Cover open ends of fused pipe at the end of each day's Work. Cap to prevent entry by animals or debris.

C. Flange Jointing:

1. Use on flanged pipe connection sections.
2. Connect slip-on Type 316 stainless steel backup flanges with Type 316 stainless steel nuts and bolts.
3. Butt fuse fabricated flange adapters to pipe.
4. Observe following precautions in connection of flange joints.
 - a. Align flanges or flange/valve connections to provide tight seal. Require nitrile-butadiene gaskets if needed to achieve seal. Integral flange adapters and gaskets are required for flange/valve connections.
 - b. Place U.S. Standard round washers as may be required on some flanges in accordance with manufacturer's recommendations. Bolts shall be lubricated in accordance with manufacturer's recommendations.
 - c. Tighten flange bolts in sequence and accordance with manufacturer's recommendations. CAUTION: Do not over-torque bolts.
5. Pull bolt down by degrees to uniform torque in accordance with manufacturer's recommendation.
6. Install electrofusion couplers, where used, in accordance with manufacturer's specifications.

D. Pipe Placement:

1. Grade control equipment shall be of type to accurately maintain design grades and slopes during installation of pipe.
2. Dewatering: Remove standing water in trench before pipe installation.
3. Unless otherwise specifically stated, install pipe in accordance with manufacturer's recommendations.
4. Maximum lengths of fused pipe to be handled as one section shall be placed according to manufacturer's recommendations as to pipe size, pipe SDR, and topography so as not to cause excessive gouging or surface abrasion, but shall not exceed 400 feet.
5. Cap pipe sections longer than single joining (usually 50 feet) on both ends during placement, except during fusing operations.
6. Notify ENGINEER prior to installing pipe into trench and allow time for ENGINEER'S inspection.
 - a. Correct irregularities found during inspection.
7. Complete tie-ins within trench whenever possible to prevent overstressed connections.
8. Allow pipe sufficient time to adjust to trench temperature prior to testing, segment tie-ins or backfilling activity.
9. Install reducers adjacent to laterals and tees.
10. To reduce branch saddle stress, install saddles at slope equal to and continuous with lateral piping.
11. Pipe shall be snaked in trench to allow a minimum of 12-inches/100 feet for thermal contraction and expansion.
12. Allow extra length at future connection points to be cut to fit after backfill and prior to tie-in.

- E. Saddle tees 8-inches and smaller may be field fabricated. Field fabrication may only be performed by persons trained and certified by the manufacturer. Submit certification of qualified persons before fabricating any saddle tees. Saddle tees larger than 8-inches must be factory manufactured.

3.2 FIELD QUALITY CONTROL

- A. Pipe may be rejected for failure to conform to these Specifications or following:
1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2-inches in length at either end of pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than five percent of shipment or delivery.
 2. Cracks sufficient to impair strength, durability or serviceability of pipe.
 3. Defects indicating improper proportioning, mixing, and molding.
 4. Damaged ends, where such damage prevents making satisfactory joint.
 5. Gouges or scrapes exceeding ten percent of the specified wall thickness.

- B. Acceptance of fittings, stubs or other specifically fabricated pipe sections shall be based on visual inspection at Site and documentation of conformance to these Specifications.
- C. CONTRACTOR to provide as-built of pipe end point and angle point coordinates and elevations prior to backfilling trench.

3.3 LEAKAGE TESTS

- A. Refer to Section 33 05 05, Buried Piping Installation.

+ + END OF SECTION + +

SECTION 40 68 26

HOSTED SCADA SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all hosted SCADA services and ancillary equipment.

1.2 QUALITY ASSURANCE

- A. Standards, Codes and Regulations:
 - 1. Construction of SCADA systems and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes, and regulations:
 - a. National Fire Protection Association 79, Annex "D" Standards, (NFPA).
 - b. National Electrical Code, (NEC).
 - c. National Electrical Manufacturer's Association Standards, (NEMA).
 - d. American Society for Testing and Materials, (ASTM).
 - e. Operational Safety and Health Administration Regulations, (OSHA).
 - f. Underwriters' Laboratory, Inc., (UL).
 - g. State and Local code requirements.
 - h. Where any conflict arises between codes or standards, the more stringent requirement shall apply.
 - 2. All materials and equipment shall be new, and all panels shall be built in an Underwriters' Laboratory, Inc. (UL) approved panel shop and bear the UL label.

1.3 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Product Data:
 - a. Manufacturer's literature, specifications, and engineering data for low volt insulated cable proposed for use.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

- A. The Hosted SCADA Service and equipment shall be Kennedy Industries integrated KI System Master (KISM) or Utilities Instrumentation Services (UIS) SCADA or approved equal.
- B. The Hosted SCADA Company shall be available to the CUSTOMER 24 hours per day, 7 days per week. At minimum, the Hosted SCADA Company shall have a controls team with a least three (3) Controls Engineers, two (2) Controls Technicians, one (1) Controls Coordinator, and seven (7) field service technicians.
- C. The Hosted SCADA Company shall provide 3 days of onsite time for customer interfacing, programming, and screen development for each associated pump station.
- D. The hardware and software of Hosted SCADA service shall be installed into two separate facilities.
- E. The Main Hosted SCADA facility shall include the following:
 - 1. Facility shall be located in Michigan.
 - 2. Facility shall be in a location historically free from natural disasters such as hurricanes, floods, earthquakes, and tsunamis. The Facility shall be above the 500 year flood plain.
 - 3. Facility shall be monitored by Facility staff 24 hours a day, 365 days a year.
 - 4. Facility shall have doorways managed by a card access system with dual authentication with biometric scanner for physical access which records all access. Security alarms to elicit an armed response.
 - 5. Facility at a minimum shall be AICPA SOC2 Type II audited. SOC2 Type II is a nationally recognized standard used to assess procedures and controls. The SOC2 Type II audit evaluates the security, operational polices and systems in use. The audit appraises the physical building security, room access control, network resiliency, backup power, environmental controls such as heat rejection, and safety systems including fire suppression.
 - 6. Facility at a minimum shall have nine redundant fiber paths for Internet connectivity leading to multiple upstream carriers. Including: AT&T, Comcast, Comlink, Level3, US Signal, and Waveform Tech with connectivity capabilities to CenturyLink, Orange Business, Sprint, Verizon, and XO Communications.
 - 7. Facility cooling and HVAC at a minimum shall be configured to ASHRAE standards with 20 degree differential between hot and cold isles.
 - 8. Facility at a minimum shall utilize an N+N UPS system with independent power delivery from transfer switch to racks. Total battery life shall be at least 20 minutes at full load. UPS system at minimum to meet or exceed concurrent maintainability tier II requirements of the Uptime Institute.

9. Facility at a minimum shall be FEMA rated and utilize N+N generator backup system. Including two diesel generators and two 2,000 gallon fuel tanks. System must run for at least 96 hours under full load before refueling.
 10. Facility at a minimum shall utilize a waterless fire suppression system.
 11. Facility at a minimum shall have an advanced security framework to safeguard both the interior and exterior of the facility. At a minimum, the system shall track all environmental functions including room temperature, humidity, and equipment conditions.
- F. The Backup Hosted SCADA facility shall include the following:
1. The Backup facility shall include identical SCADA hardware and software as the Main facility.
 2. The Backup facility SCADA software shall be securely synced with the Main facility SCADA software at all times. This includes SCADA software programming and historical data logging.
 3. The Backup facility shall continuously monitor the Main facility and act as a hot-backup when the Main facility is unavailable. The Backup facility shall perform all Hosted SCADA functions immediately and automatically.
 4. The Backup facility shall be on a different power grid than the Main facility.
 5. The Backup facility shall be owned by the Hosted SCADA provider
- G. The Hosted SCADA system shall include the following hardware:
1. Main runtime SCADA server utilizing Server operating system and server features.
 2. Backup runtime SCADA server utilizing Server operating system and server features.
 3. Twelve (12) available voice modems for alarm callouts. Six (6) voice modems to be installed on main runtime server. Six (6) voice modems to be installed on backup runtime server.
 4. Four (4) different voice phone line technologies shall be used: Standard POTS lines, Cellular voice lines, Digital PBX lines, and VOIP lines.
- H. The Main SCADA system and Backup SCADA system shall have scheduled plans in place to monitor and ensure the uptime and stability of the Hosted SCADA service. These services shall be performed by 3rd parties:
1. IT Infrastructure Audit – The Hosted SCADA main and backup IT infrastructure shall be audited yearly by a 3rd party IT professional. Recommendations by the 3rd party IT professional shall be implemented within 6 months.
 2. Disaster Recovery Testing – The Hosted SCADA main and backup IT infrastructures shall be tested against a disaster recovery plan yearly. The disaster recovery plan shall be reviewed and tested by a 3rd party IT professional.

3. Uptime Monitoring of Hosted SCADA Service – The Hosted SCADA main and backup IT infrastructures shall be monitored by a 3rd party company every 5 minutes. If the 3rd party company is unable to access the Main SCADA system or Backup SCADA system, the 3rd party shall notify the Hosted SCADA Company immediately.
4. IT Infrastructure Health Monitoring – The Hosted SCADA main and backup IT infrastructure shall be monitored by 3rd party software. If the 3rd party software identifies an issue with the IT infrastructure, another 3rd party voice callout provider shall notify the Hosted SCADA Company immediately.

2.2 I/O COMMUNICATIONS

- A. The Hosted SCADA system shall provide the ability to communicate to customer equipment using cellular communications for potential future use. The cellular communication shall incorporate the following:
 1. Contracts with multiple service providers including Verizon, AT&T and Sprint.
 2. Cellular data to be private and secured by service provider. Hosted SCADA system shall have VPN access to each cellular service provider to securely access cellular data.
- B. Communications diagnostics tools shall be included to aid in the visualization of proper communications. Tools shall include methods for monitoring communication statistics and reporting errors.
- C. Software shall be capable of supporting local I/O communications (i.e. on the primary application server) or distributed I/O servers (i.e. on computers other than the primary server.) There shall be no limit to the number of allowable redundant I/O servers for any driver.
- D. Software shall be capable of pooling modems connected to one of more servers, for use in I/O communications.
- E. Software shall support multiple communications protocols over a single communications port. Communications drivers shall be capable of sharing communications equipment, such as a radio tower (where there is no difference in radio frequency) or a pool of shared modems.
- F. Software shall support redundant physical links to any field device, such as primary connectivity via Ethernet and redundant connectivity via serial port. Redundant links shall support similar or different protocols.
- G. I/O drivers shall be available at no additional cost for a variety of protocols, as follows:
 1. Modbus (TCP, RTU, ASCII, Plus, Serial).
 2. AB DF1.
 3. CIP.
 4. DNP3.

5. Omron Hostlink and FINS.
 6. Bristol Babcock BSAP and IBP.
 7. GE SNP and SNPX.
 8. SNMP.
- H. OPC Client connectivity shall be available at no additional cost for drivers not included in the preceding list. This shall support OPC Servers from developers.
- I. DDE Client connectivity shall be available at no additional cost.
- J. Software shall support the development of additional I/O drivers where necessary.
- K. To optimize system performance, software must support multi-threaded operations for I/O drivers.
- L. Software shall provide tools for polling remote devices (e.g. RTUs) directly. Software shall allow real-time tuning of each device's polling frequency without interrupting the polling cycle or restarting the application.
- M. To optimize I/O communications for telemetry applications, the polling order shall be configurable, and polling shall be asynchronous (if permitted by the remote telemetry unit), allowing the system to continue its polling sequence in the event of a communications error with the remote device.
- N. Software shall support radio diagnostics drivers for the following radio devices:
 1. Dataradio/Calamp.
 2. MDS.
- O. Software shall support writing to multiple output tags via a single write request. This shall allow writing a set of default values to a set group of field device registers.
- P. Software shall support rewriting the last written value to an output.

2.3 SYSTEM CONFIGURATION

- A. Configuration files and configuration history shall be encrypted.
- B. Change deployment shall be either automatic or manual. User's choice.
- C. Software shall allow configuration changes to be reviewed before they are deployed. Users shall have the option to roll back specific changes and deploy others.
- D. Software shall be capable of on-line configuration. That is, changes to tag configuration, server lists, user displays, security, reports development and I/O communications shall be carried out without stopping and restarting the application or the computers and without recompiling the application.

- E. Software shall be capable of testing on-line configuration changes to tags and screens using live data before changes are deployed.
- F. Software shall allow multiple users to configure an application simultaneously.
- G. Software shall be capable of offline changes which can be manually imported to the running application and extracted automatically.
- H. Software shall allow changes to the application server lists without requiring the application to be restarted.
- I. Any client computer not running the application while changes are being made shall automatically download newly deployed changes from the primary application server when the client is restarted.
- J. All application servers and clients shall automatically synchronize with the primary application server. No manual file duplication shall be required.

2.4 VERSION CONTROL

- A. Software shall offer integrated version control, such that a complete version history exists for any application. The entire version history shall reside in an encrypted repository.
- B. The version history shall include the time and date when the change was applied, the user who deployed the change and any comments entered by the user when deploying this change.
- C. The version history shall allow review of any incremental application changes, including displays, graphics, tags, and scripts for each deployed version.
- D. A tool shall be available to determine what versions of the application each (full installation) client or server computer is currently running.
- E. Software shall allow rollback to a previous version of the application without stopping and restarting the application.

2.5 TAG DATABASE

- A. Software shall be tag-based.
- B. Tag structures shall be supported, such that a custom tag structure can include a set of typical I/O tags (e.g. a lift station.) Structures shall support a base address such that its I/O may use referential addressing.
- C. Tag structures shall be treated as templates in that any structure can be copied and pasted to create any number of identical structures.

- D. A browser shall be provided for creation, modification, and deletion of each individual tag.
- E. The tag browser shall include a summary of all tags' current values.
- F. Software shall provide a tool for export of all application tags to Microsoft office applications for bulk tag changes and for import of all tags from the same programs.

2.6 GRAPHICS AND DISPLAY

- A. Software shall not limit the number of application displays that can be created.
- B. Software shall support both animated and static graphic objects. Animated graphic objects shall provide real-time process information to the user via displays.
- C. Software shall include a standard library of graphics and shall allow additional graphical elements (e.g. BMP, JPG, PNG) to be inserted into the library.
- D. Software shall support the following display sizing and placement features:
 - 1. Minimum and maximum display sizes for each display.
 - 2. Resizing, minimizing, maximizing.
 - 3. Automatic resizing displays to the workstation resolution of each user viewing the application. This shall be supported on both fully installed and browser clients.
- E. Process displays shall be event-driven, in that data will be delivered to client computers by the server immediately upon receipt. Client computers will not poll the server for new data.
- F. Standard tag types with graphics shall be provided for the following:
 - 1. Analog/digital inputs.
 - 2. Analog/digital outputs.
 - 3. Retentive counters with reset. (Values should persist if power is lost and subsequently restored.)
 - 4. Retentive totalizers with reset. (Values should persist if power is lost and subsequently restored.)
 - 5. Multi-position switches. Position changes sent to field devices must include feedback of status received and verification of field action taken. For example, a switch intended to turn on a pump shall generate an alarm if the pump running status is not received within a predefined timeout.
 - 6. Alarms.

- G. Software shall include pre-built displays for standard SCADA features. The following pre-built displays shall be provided as a minimum:
 - 1. Alarm display that can be filtered by name and includes current, unacknowledged, disabled and history.
 - 2. Trending and tabular viewing of historical data.
 - 3. Report creator.
 - 4. Operator notebook.
- H. Software shall include the following navigation tools:
 - 1. A menu for navigating from one display to another. Menu shall be configurable to allow logical grouping of displays where necessary.
 - 2. Hot box for navigating to a specific display.
 - 3. Button for navigating to a specific display.
 - 4. Browser-like forward and reverse buttons to view 10 (or more) previously viewed displays.
- I. Software shall allow color translations, changing brightness, contrast, and transparency for all graphical library objects. An easy-to-use integrated interface shall be provided to facilitate these changes.
- J. Software shall allow calculations to be associated with each graphic object to facilitate movement, visibility, and sizing.
- K. Software shall allow multiple objects to be saved as a grouped template. The following template capabilities shall be supported:
 - 1. A template may be associated with a tag structure.
 - 2. Each new instance of the template will inherit the properties of the template, such that changes to the template will automatically update all instances created from it.
 - 3. The template may have any number of parameters, including tags and text values, which can be used to animate objects within the template. Each new object created from the template may include different parameters.
 - 4. Templates may be imported from other projects.
 - 5. Copy/paste/rename/delete for any template.
 - 6. Ungrouping of any instance of the template.
- L. Project displays shall be treated as template displays. The following capabilities shall be supported:
 - 1. A template display may be associated with a tag structure.
 - 2. Each new instance of the template will inherit the properties of the template, such that changes to the template will automatically update all instances created from it.
 - 3. The template may have any number of parameters, including tags and text values, which can be used to animate objects within the template. Each new object created from the template may include different parameters.
 - 4. Templates may be imported from other projects.
 - 5. Copy/paste/rename/delete for any template.

- M. Means shall be provided to allow the operator to print graphical displays.
- N. Software shall support flagging tags as ‘questionable data’ or ‘not commissioned’, though they will continue to display the incoming values. These flags shall be removable by users with sufficient privileges.
- O. Software shall include an object-oriented graphics and animation editor with the following capabilities:
 - 1. Drawing tools with CAD-like capabilities for drawing animated and static objects and text. Developers shall have access to a user-configurable grid for use in positioning objects.
 - 2. Editing tools for adding, aligning, layering, sizing, copying, cutting, pasting, and deleting objects.
 - 3. Creating graphics that rotate/move at a rate corresponding to the value they are displaying.
 - 4. Importing 3D graphic images rendered using external software tools.
- P. There shall be no limit to the number of animation graphics that can be used to represent the same I/O tag.
- Q. Software shall support background bitmaps on graphical pages.
- R. Software shall be capable of displaying multiple graphical windows simultaneously.

2.7 HISTORICAL DATA STORAGE

- A. Software shall include an integrated, no-cost historian and have a redundant MSSQL historian for backup and custom reporting.
- B. Software shall be capable of logging up to 10,000 values per second.
- C. A synchronization scheme shall be included such that an exact copy of all historical data resides in two computers. The scheme shall provide synchronization of data between the software’s proprietary historian and MSSQL. Software shall be capable of synchronizing up to 4000 values per second across each historian type.
- D. If, at any time a historian is out of service for duration of time, this historian shall be automatically resynchronized with the historian holding the most recent logged data.

2.8 HISTORICAL DATA ANALYSIS

- A. Any tag configured as an Analog Status or Digital Status tag shall be automatically available for trending on screen displays.
- B. Software shall provide a tool for users to generate ad-hoc trends of historical data and shall allow these trends to be saved for later recall.
- C. Software shall display historical and real-time data in both plot and tabular format. Historical and real-time plotted values shall be shown in a continuous, uninterrupted, scrolling fashion.
- D. The plot's time frame shall be operator selectable from a minimum of one second to five years. Time intervals shall be clearly marked on the x-axis with date/time stamps and shall scroll with the data.
- E. Scaling of each displayed tag value shall be either user-configurable or shall follow the scaling of the tag. Changing the scaling of the tag plot shall not affect the scaling of the tag.
- F. User shall be able to see the value of plotted tags for any selected point in time.
- G. Software shall be capable of displaying an unlimited number of analog and digital tag plots on a single display. Color shall be used to differentiate between tags. Means must be provided to quickly determine the name and description of each tag displayed.
- H. Means must be provided for the following:
 - 1. Stop/pause scrolling.
 - 2. Zoom in/out on the time (x) and value (y) axis.
 - 3. Pan/Scroll along the time axis or select a particular date to display.
 - 4. Move analog tag plots vertically (in the value (y) axis), either individually or as a group
 - 5. Display statistical data, including average, minimum and maximum values, for each plot.
- I. Ability to print displayed plots shall be provided.
- J. Ability to associate an operator note with a particular point in time shall be provided.
- K. Trend data shall be exportable to comma separated value (.csv) file or directly to a database, for use by 3rd-party data analysis software.
- L. Software shall include simple methods for generating historical calculations, such as average flow over last 24 hours.

2.9 ALARMS AND EVENT MANAGEMENT

- A. A synchronization scheme shall be included such that an exact copy of all alarms and events data resides in two computers.
- B. If, at any time an alarms/events server is out of service for duration of time, it shall be automatically resynchronized with the more updated alarms/events server.
- C. Software shall allow the application to be split into functional areas such that the alarms a user sees/acknowledges are determined by the areas to which the user has access.
- D. Software shall support generation of an alarm or event for I/O driver loss of communications, tag value change or outside range, calculated value, user logon/logoff, excess rate of change, stale value and server startup.
- E. Software shall provide user-configurable settings for deadband on analog alarms and delay on analog and digital alarms.
- F. Each alarm and event shall be written to the application's alarms/events history.
- G. Software shall support printing of alarms/events created over a range of dates/times.
- H. Alarms and events records shall include:
 - 1. Time/Date stamp.
 - 2. The name and description of the alarm tag.
 - 3. Priority.
 - 4. Status of Alarm (i.e. Active, Acknowledged, Cleared). Alarm Acknowledgement records shall include the name of the user.
- I. Users shall be able to filter the alarms display to show current, unacknowledged, disabled, or historical alarms/event. Alarms shall be filterable by priority or by alarm areas/groups.
- J. Software shall support an unlimited number of alarm priorities and shall allow unique annunciation sounds and colors for each.
- K. Alarm annunciation shall be configurable to use alarm tones, text to speech descriptions, or sound files.
- L. Users must be notified, both visibly and audibly, of the occurrence of an alarm, regardless which display is presently being viewed.
- M. Alarm acknowledgement shall immediately be propagated to all user interfaces.

2.10 ALARM DIALER

- A. The dialer shall perform alarm annunciation via dial-out over voice modem (using text-to-speech), text message, email and/or alphanumeric pager. It shall support alarm acknowledgement during voice modem calls and via email.
- B. The dialer shall be configurable from the SCADA software configuration license and be automatically synchronized with the tag database at all times.
- C. Email messages shall support outgoing mail with transport layer security (e.g. Gmail, Yahoo Mail.)
- D. The dialer shall share the SCADA system security, requiring users to enter a username and security code access data and to acknowledge alarms.
- E. The dialer shall be capable of annunciating alarms to rosters of users with up to 30 contacts per roster. An unlimited number of rosters shall be supported.
- F. The dialer shall be able to make rosters active/inactive manually or automatically. Changes to rosters and active/inactive status changes shall be made without stopping and restarting the application or computer.

2.11 SECURITY

- A. Software shall include a security system with privilege and role-based user accounts. Level-based access shall not be acceptable.
- B. Security system shall support an unlimited number of user accounts, roles, and access privileges.
- C. System shall allow creation of an unlimited number of additional security privileges where necessary.
- D. User passwords shall be stored in an encrypted format.
- E. User passwords must be configurable to require a minimum length, contain alphanumeric characters, and expire after a pre-set period.
- F. System shall allow changes to user accounts, roles, and privileges while the application is running. Changes shall become effective immediately. Networked users whose accounts have been altered shall be affected by the changes immediately without requiring application restart.
- G. User login and logout activity shall be recorded in the application event log.
- H. Disabling accounts after X failed attempts shall be supported.

2.12 ELECTRIC OPERATOR NOTEBOOK

- A. Software shall include a networked electronic operator notebook. All notes entered into the notebook shall be immediately viewable from all clients and servers.
- B. Each note shall be recorded with a time/date stamp and the name of the user's account.
- C. Notes shall be encrypted to minimize the risk of tampering.
- D. Users shall be permitted to select any date to review notes generated on that date.
- E. Software shall support printing of notes created over a range of dates/times.

2.13 REPORT GENERATION SYSTEM

- A. Software shall be capable of producing reports using historical data. Reports may be created for one-time use or saved for reuse.
- B. Report generation shall be invoked either on demand, by a monitored event, or on a scheduled basis.
- C. The report generation system shall be field configurable, allowing an operator to create, modify and generate reports and export data to third party software. The report generation system shall be capable of displaying reports to the user interface display or of exporting files per the following:
 - 1. To a comma separated value (.csv) file.
 - 2. To a text file.
 - 3. To an ODBC-compliant database.
 - 4. To any direct-connected or networked printer.
 - 5. Directly to a new MS Excel spreadsheet.
 - 6. Directly to a new MS Excel template.
 - 7. To an e-mail.
- D. Reports shall be able to display any analog, digital or calculated tag data from the historical database.
- E. The Hosted SCADA system shall perform custom reporting utilizing templates as needed by the customer. The system shall be able to report using MS Excel utilizing custom VBA coding, or by using XLReporter software.

2.14 INTERNET CONNECTIVITY

- A. The Hosted SCADA system shall provide a custom domain name for the customer.
- B. The Internet Client shall be protected with Secure Socket Layer (SSL) security.
- C. The Internet Client shall require users to enter a username and security code to run the client.
- D. Internet connectivity shall not require the installation or configuration of Internet server software (e.g. Microsoft IIS, Apache).
- E. On-line configuration changes shall be pushed immediately to all Internet client interfaces without requiring the browser interface to be restarted or refreshed.
- F. Internet clients shall require only the latest version Microsoft Internet Explorer to communicate with the application. Internet clients shall require no software to be manually installed.
- G. Internet clients shall cache displays in order to reduce display access time.
- H. Internet clients shall have graphical displays identical to the standard full-installation client and shall not require separate development time or a separate development interface. The automatic display generation process shall not distort the graphical layout of any display.
- I. Tools shall be provided to monitor Internet client connectivity and to disconnect users when necessary.
- J. The Hosted SCADA system shall provide FTP access to a secure area of the Hosted servers. This functionality provides electronic storage for any document(s) selected by the customer.

2.15 HANDHELD DEVICE CONNECTIVITY

- A. Handheld device connectivity shall share the SCADA system security, requiring users to enter a username and security code.
- B. Software shall support the following functionality via hand-held devices, such as iPhone, iPad, Blackberry and Android, etc.
 - 1. Alarms access and acknowledgement.
 - 2. Analog and digital input monitoring.
 - 3. Analog and digital output control.
 - 4. Real-time and historical data trends.
- C. Zoom in (pinch) and zoom out shall be supported for historical data trends.

2.16 SCREEN DISPLAY

- A. The software shall include 3D models of customer pumps. The models shall be developed in CAD software. The pumps shall show a red impeller when not running. The pumps shall show a green impeller, with animation for rotation, when running.

2.17 SERVER REDUNDANCY AND LOAD BALANCING

- A. A minimum of three levels of redundancy for all application services shall be supported.
- B. Software shall support automatic failover from a primary server to one or more backup servers for all application services. No manual intervention shall be required.
- C. Software shall support distribution of services across any number of computers to facilitate load sharing.
- D. Software shall automatically redirect Internet Client connections to the Internet Server with the least active connections.
- E. All servers shall be aware of which server is in control of each software process. No two servers shall perform the same function at the same time (e.g. I/O communications to a specific device, incrementing a totalizer.) This ensures efficient use of network communications and synchronization of data across the SCADA network.
- F. Software must not require each redundant server to use a second network card to monitor the status of the primary server.
- G. Software shall support redundant networks and shall be able to use these for load distribution when both are available. In the event one network connection is lost, network communications shall automatically fail-over to the second connection.

2.18 APPLICATION UPGRADES / SUPPORT / DIAGNOSTICS / DEBUGGING

- A. Users must have the capability to upgrade the base software product as new versions become available. Such upgrades shall not require significant changes to the existing application.
- B. Support shall include phone, email, user forum and remote access methods.
- C. Training shall be available for users of all levels (i.e. Operators, Developers, Administrators)
- D. Diagnostic/debugging tools shall be provided.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment in conformance with NEC.
- B. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as indicated on the Drawings.

+ + END OF SECTION + +

SECTION 40 69 50

PACKAGED SMART PUMP CONTROL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation packaged smart pump control systems at Lift Stations A, B, C, D, E, F, G, K, L, M, Q, R, and S.

B. Related Sections:

1. Section 03 00 05, Concrete.
2. Section 05 05 33, Anchorage Systems.
3. Section 31 23 05, Excavation and Fill.

1.2 ALTERNATIVE PRODUCTS AND MANUFACTURERS

- A. Alternative A: Bidders must provide pricing (add or deduct) on the Bid Form for providing the packaged smart pump control systems specified in this section, in lieu of providing the pump system control panels specified in Section 33 32 00, Packaged Sanitary Drain Lift Stations, by Base Bid Sanitary Drain Lift Station supplier, Flygt, a Xylem Corporation Brand, for the stations indicated.

1.3 QUALITY ASSURANCE

A. Standards, Codes and Regulations:

1. Construction of packaged smart pump control systems and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes, and regulations:
 - a. National Fire Protection Association 79, Annex "D" Standards, (NFPA).
 - b. National Electrical Code, (NEC).
 - c. National Electrical Manufacturer's Association Standards, (NEMA).
 - d. American Society for Testing and Materials, (ASTM).
 - e. Operational Safety and Health Administration Regulations, (OSHA).
 - f. Underwriters' Laboratory, Inc., (UL).
 - g. State and Local code requirements.
 - h. Where any conflict arises between codes or standards, the more stringent requirement shall apply.
2. All materials and equipment shall be new and all panels shall be built in an Underwriters' Laboratory, Inc. (UL) approved panel shop and bear the UL label.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Shop Drawings of pump controls specified in this Section, including panel layout and wiring diagrams.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, paint certification (if required) and engineering data including: dimensions, materials, size, weight, and part lists for all components in sufficient detail to allow an item-by-item comparison with the Contract Documents.
 - 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Provide pump Supplier's proposed shop testing plan, including complete list of testing facility limitations.
 - b. Provide proposed field-testing plan.
- B. Informational Submittals:
 - 1. Manufacturer Instructions:
 - a. Provide manufacturer's instructions for handling and installing products.
 - b. Setting drawings, templates, and directions for installing anchor bolts and other anchorages.
 - 2. Source Quality Control Submittals:
 - a. Results of shop testing.
 - 3. Field Quality Control Submittals:
 - a. Results of field testing.
- C. Closeout Submittals: Submit the following:
 - 1. Operation and Maintenance Manuals:
 - a. Submit complete operation and maintenance manuals, including shop and field test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Provide operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
 - 2. Warranty Documentation:
 - a. Manufacturer's Standard Warranty.
 - b. Special Warranty, if specified.
- D. Maintenance Material Submittals: Furnish the following:
 - 1. Spare Parts for each control panel:
 - a. One spare fuse for each fuse in pump control panel.
 - b. One spare pilot light for each pilot light in pump control panel.
 - 2. Spare Parts for Project:
 - a. One breaker for each type and size installed.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
 - 1. Prior to shipping, completely inspect products to assure that components are complete and comply with all requirements. Box or crate products as required to prevent damage during shipment.
 - 2. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 - 3. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
 - 4. Comply with Section 01 65 00, Product Delivery Requirements.
- B. Storage and Protection:
 - 1. Keep all products off ground using pallets, platforms, or other supports. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 - 2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

1.6 WARRANTY

- A. Special Warranty on Packaged Smart Pump Control Systems:
 - 1. Provide manufacturer's written non prorated warranty, running to the benefit of OWNER, agreeing to correct, at OWNER's option, remove, or replace materials or equipment specified in this Section and found to be defective for a period of five years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

- A. The Packaged SMART Pump Control Systems shall provide control of a typical pump station, with an intuitive user-interface. The product shall come with pre-built configuration parameters which are selectable via the user interface, including:
 - 1. Functionality for advanced pump control of up to 6 pumps.
 - 2. Pump mode, for each pump, between Auto/ Manual / Off:
 - a. In manual control (semi-automatic manual) pump switches off at deactivation setpoint and reverts to Auto mode to prevent accidental pump run on.
 - b. To pump beyond off set point in manual button must be held down (full manual).
 - 3. Setpoint adjustment for pump activation/deactivation and level alarms.
 - 4. Level device from 4-20mA, conductive probe or remote level:
 - a. Redundant level device handling.
 - 5. Selectable between fill / empty.

6. Functionality for advanced pump control of up to 6 pumps including grouping and alternation.
7. Station optimization including:
 - a. Max off time (odor reduction).
 - b. Maximum pumps to run (overload protection).
 - c. Maximum starts per hour (pump protection).
 - d. Inter-pump start and stop delays.
 - e. Maximum run time (turn off inefficient or partially blocked pumps).
 - f. Blocked pump detection.
 - g. Well washer controls.
 - h. Well clean out (periodic pump down to snore point).
 - i. Pump groups with different configurations (e.g. alternation schemes) for each group.
8. "Locked level" alarm to indicate level device problem:
 - a. User-defined % change within a time period.
 - b. Different values for low use, high use times (user defined).
9. Alternation schemes including:
 - a. Fixed lead/duty.
 - b. Alternation.
 - c. Alternation N:1 (e.g., 3:1).
 - d. Run most efficient pump, N:1 ratio, e.g. more efficient pump runs 20 times for each operation of the less efficient pump(s).
 - e. Alternation by hours run or starts.
10. Pump decommission/commission:
 - a. Decommissioned pump automatically removed from control algorithm, alarms, displays, etc.
 - b. SCADA tag flags decommissioned status.
11. Six profiles of setpoints for spill management, off peak pumping, tariffing, etc:
 - a. Automatic profile change on date/time.
 - b. Selectable from SCADA, digital input, logic tag or faceplate.
 - c. Profile includes some pump control parameters - max no of pumps, max run time, max off time.
12. Datalogger for user-defined faults and events (process values):
 - a. 50,000 events to internal flash memory.
 - b. 10,000,000 events by writing direct to Compact Flash card.
 - c. Download event and fault log as csv to Compact Flash for Excel analysis.
 - d. ftp transfer of event and fault log as csv for Excel analysis.
13. 3-phase supply monitoring and supply protection:
 - a. Under-voltage.
 - b. Over-voltage.
 - c. Phase fail.
 - d. Phase rotation.
14. Monitoring of dc supply, battery voltage, and internal temperature.

15. Energy, power and pump efficiency monitoring:
 - a. kW, kVA, power factor, kWhr, KVAH calculation for each pump.
 - b. pump efficiency calculation (litres or gals per kWhr) for each pump.
16. Motor protection including:
 - a. 3-phase current monitoring for each pump.
 - b. Over- and under-current trip.
 - c. Ground/earth fault.
 - d. Current phase imbalance fault.
 - e. I²T fault.
 - f. Insulation resistance testing for motor windings:
 - 1) Values and user-definable fault threshold.
17. Flow measurement/calculation:
 - a. Calculated flow via draw down test.
18. VFD control algorithm:
19. Fault module with flexibility for any fault to:
 - a. Hold out pump(s) or be display only.
 - b. Auto-restart after user-defined time subsequent to fault condition clearing.
 - c. Auto-restart user-defined number of times (subsequent to fault condition clearing) before locking out.
 - d. Manual/ SCADA reset required.
20. Remote control via SCADA for:
 - a. Changing mode of pumps (auto/off/manual).
 - b. Reset of pump and station faults.
 - c. Changing pump and alarm setpoints.
 - d. Changing setpoint profiles.
21. Security:
 - a. Admin user sets PINs for access to configuration of the unit.
 - b. Automatic datalogging of who has entered the configuration menu.
 - c. Automatic logging of all unsuccessful login attempts with date/time.
 - d. Digital input option, e.g. key switch, for access to configuration menu.
22. Compact Flash Port allows:
 - a. Firmware upgrades.
 - b. Save/load configuration (allows backup to be restored, or configuration copied from another station).
 - c. Download datalogger in CSV.
 - d. Export/import Modbus and DNP3 points list in csv format.
23. Provisions for connection to cellular modem shall be provided.

B. Programmability:

1. The product shall have the option of IEC61131-3 and IEC61499 compliant PLC programming language to enhance/interact with all the modules in the pump station manager.
2. The product shall have the option of a simple logic engine to enhance/interact with all the modules in the pump station manager.

2.2 I/O

A. General:

1. The I/O shall be expandable to many hundreds of I/O points per unit.
Available I/O types shall include:
 - a. Digital inputs (voltage free input), also configurable as counters.
 - b. Digital outputs (240V, 5A resistive).
 - c. Analog inputs (10bit).
 - d. Analog outputs (10bit).

B. Digital Inputs configurable for seal, thermistor, and other pump station requirements:

1. Additionally, the Digital Inputs shall be selectable as pump station specific I/O to reduce components in the panel and therefore save cost, e.g. remove pump relays such as mini-CAS relays, MAS relays.
 - a. Seal sensor (conductive).
 - b. PTC Thermistor.
 - c. Flygt FLS & CLS.
 - d. Conductive probe (for liquid level sensing).

C. Specific I/O for motor protection and current/voltage monitoring:

1. The product shall have I/O cards to minimize additional components which include:
 - a. Insulation resistance test (IRT) to 1000v.
 - b. 3-phase current monitoring, derived from CT's, 0.5% resolution.
 - c. 3-phase supply monitoring, 0.5% resolution. Up to 630V phase to phase.
2. Support for Duo Probe:
 - a. The product shall have an internal atmospheric pressure sensor to allow for atmospheric pressure sensing and correction.

D. User Interface:

1. The field hardware shall include a user interface for operations and configuration. The display shall provide status of most aspects of the pump station, control of pumps, resetting of faults, and configuration of parameters.
2. Status:
 - a. The following parameters shall be displayed on the main screen:
 - 1) Level in user definable units eg %, metres or custom units.
 - 2) Setpoints for alarms and pump start/stop.
 - 3) Pump running/stopped.
 - 4) Pump available/unavailable.
 - 5) 3-phase current for each motor.
 - 6) Faults.
 - 7) 3-phase supply.
 - 8) Date/time.
 - 9) User-configurable option to display pump efficiency, flow rates, total starts, total hours run and other parameters.

- b. The screen will also have buttons to allow the user to access Faults, History, Information and Settings.

E. Information Screens:

1. The following parameters shall be available via a user key press from the main screen:
 - a. Hours Run accumulators for each pump & the station with the following comparisons:
 - 1) Last minutes run.
 - 2) This hour, last hour.
 - 3) Today, yesterday.
 - 4) This week, last week.
 - 5) Total hours run.
 - b. Starts accumulators for each pump & the station with the following comparisons:
 - 1) This hour, last hour.
 - 2) Today, yesterday.
 - 3) This week, last week.
 - 4) Total starts.
 - c. Flow values, either derived from calculations or via a flowmeter:
 - 1) Inflow.
 - 2) Pump flow rate.
 - 3) Total volume.
 - 4) Overflow data, including start time, duration, estimated volume.
 - d. Power & efficiency:
 - 1) Pump efficiency in litres or gals per kWhr - or KVAH.
 - 2) Power in kW, kVA.
 - 3) Power factor.
 - 4) Energy accumulators per pump in KWHr and KVAH.
 - e. Insulation resistance value for each motor from 1000V test.
 - f. Status of all I/O:
 - 1) Digital I/O open/closed and accumulator.
 - 2) Analog I/O mA and scaled.
 - 3) 3-phase voltage, current, frequency, phase angle, power factor.
 - g. Database viewer to view all datapoints/tags in real time.
 - h. Communications stats.

F. Control:

1. The following aspects of the system, as a minimum, shall be controlled intuitively through the user-interface:
 - a. Pump mode, for each pump, between Auto/ Manual (Hand)/ Off.
 - b. Pump fault reset.
 - c. Level alarm reset.

G. Fault Screen:

1. The main screen shall include a Fault button which takes the user to a Fault screen and allows them to check all current and unacknowledged alarms.
2. The fault screen will detail the fault (e.g. contactor fail, seal fault, motor overtemp, over-current, etc) along with date/time each fault occurred and cleared.
3. A reset option for a fault will be presented to the user when faults can be acknowledged/reset.

H. History Screen:

1. The main screen shall include a History button which takes the user to a History screen:
 - a. View all date/time stamped faults and events.
 - b. Filter by pump or other station parameters, by time period.
 - c. Export via CSV for analysis in Excel.

I. Configuration:

1. The user interface should allow intuitive configuration of the system, including as a minimum:
 - a. Setup Wizard to allow a complete configuration (display, IO and configuration of functional blocks) by the user answering simple questions.
 - b. Set-points, including alarm and pump setpoints.
 - c. Enable/disable level alarms (so that for example, the low-level alarm can be easily activated or deactivated).
 - d. Start, stop and alarm delays.
 - e. Alternation/ fixed sequence and grouping of pumps where necessary.
2. Configure I/O:
 - a. Assign primary/backup level to any input, e.g. 4-20mA or conductive probe.
 - b. Assign pre-defined (or user-defined) faults, e.g. thermal overload, contactor fail, to any digital input.
 - c. Zero and span analog inputs.
 - d. Set Digital outputs to change state with any digital tag in the system.
 - e. Set Analog outputs to follow any analog value, including primary level.
3. Fault configuration for each fault to either:
 - a. Display only.
 - b. Manual/SCADA reset before pump becomes available.
 - c. Auto-restart (after fault condition clears) with configurable restart time.
 - d. Auto-restart user-selectable number of times within time window before locking out.
 - e. Customized text for fault and event name.
4. Pump station optimization parameters such as:
 - a. Max off time (odor reduction).
 - b. Maximum pumps to run (overload protection).
 - c. Maximum starts per hour (pump protection).
 - d. Inter-pump start and stop delays.

- e. Maximum run time (turn off inefficient or partially blocked pumps).
 - f. Well washer controls.
 - g. Well clean out (periodic pump down to snore point).
 - h. Random duty start (random time after activation point reached before pump starts) to reduce fat build up.
 - i. Optimization parameters applied differently to different groups of pumps if required.
5. Supply protection:
 - a. Under- and over-voltage alarm points.
 - b. Volts phase imbalance and volts phase rotation.
 - c. DC-supply alarm point.
 6. Motor protection:
 - a. Under-current.
 - b. Over-current.
 - c. Ground/earth fault.
 - d. Phase fail.
 - e. I²T protection.
 7. Communications ports, speeds, and addresses.
 8. The configuration of the unit will also allow the user to save a known good configuration on the unit itself that they can revert back to at any time.
 9. Configuration backup and restore & Firmware upgrades:
 - a. The Configuration interface will allow the user to save and restore configurations onto a SD card or USB storage device, to allow easy configuration from saved versions (or copying settings from one site to another).
 - b. The unit will allow the user to backup system log files, alarm and event log files, and custom scripts via the SD or USB ports.
 - c. The unit shall allow for the import of DNP3 and Modbus point lists and custom logic scripts via the SD or USB ports.
 - d. Firmware upgrades will be possible by copying the upgrade image onto a SD card, or USB storage device, then inserting into a field unit and cycling power.
 10. Maintainability:
 - a. The supplier shall also demonstrate that their system is maintainable in the future, especially that future applications do not incur any user-interface development cost on the customer, i.e., the user-interface shall be an integral part of the system.

J. Communications:

1. Integral RTU/outstation.
2. Physical:
 - a. The product shall include:
 - 1) Two Ethernet ports to 10Mbit/s.
 - 2) Two RS232 ports to 115kBit/s.
 - 3) Two RS485 ports to 115kBit/s.

3. Media:
 - a. The system shall support a variety of media and communications networks including:
 - 1) TCP/IP.
 - 2) UDP.
 - 3) RS232.
 - 4) RS485.
 - 5) Private radio over RS232.
 - 6) PSTN.
 - 7) Wireless LAN.
 - 8) Cellular data (via integral ppm module).
 - 9) Cellular voice.
4. Protocols:
 - a. DNP3 master & slave, level 2 compliant, including:
 - 1) Change of state reporting.
 - 2) Native date/time and quality stamps for each data point.
 - 3) Event buffering for different classes of data.
 - 4) Support for multiple masters and slaves to be configured on the unit.
 - b. DNP Security (for securing communications between master station and RTU) Modbus master & slave including:
 - 1) Modbus TCP.
 - 2) Modbus RTU.
 - 3) Modbus ASCII.
 - 4) Support for multiple masters and slaves to be configured on the unit.
 - c. Communications redundancy supported.
5. Full Remote Control of Pump Station:
 - a. Pump control and configuration tags allow integrated remote control via SCADA including:
 - 1) Start / stop pumps (change mode to auto/ off/ manual).
 - 2) Reset pump and station faults.
 - 3) Change pump & alarm setpoints.
 - 4) Change setpoint profile.

K. Environmental:

1. The unit shall meet the following environmental ratings:
 - a. Working Temperature: -10°C to +60°C.
 - b. Storage Temperature: -40°C to +90°C.
 - c. Humidity: 5% to 95% (non-condensing).
 - d. IP Rating:
 - 1) Controller: IP20, Nema 1.
 - 2) Display: IP65, Nema 4.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment according to manufacturer's recommendations.
- B. Install equipment in conformance with NEC.
- C. Install anchor bolts and anchor in accordance with Section 05 05 33, Anchorage Systems.
- D. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as indicated on the Drawings.

3.2 TESTING AND ADJUSTMENTS

- A. Perform system testing and make any adjustments necessary in accordance with this Section.
- B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

++ END OF SECTION ++

SECTION 40 70 05

MAGENTIC FLOW METERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all magnetic flow meters shown and specified herein.
 - 2. CONTRACTOR shall be responsible for installing in-line flow elements (magnetic flow meter flow tubes, insert flow tubes, propeller flow meters).
- B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

1.2 QUALITY ASSURANCE

- A. Acceptable Manufacturers:
 - 1. Furnish magnetic flow meters by the named manufacturers or equal equipment by other manufacturers.
 - 2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
 - 3. Obtain all magnetic flow meters from the same manufacturer.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Primary process measurement devices shall not be delivered to the Site until all product information and system Shop Drawings for the sensors and instruments have been approved by the ENGINEER.

1.4 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
 - b. Instrument tag number in accordance with the Contract Documents.
 - c. Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
 - d. Description of construction features.
 - e. Performance and operation data.

- f. Installation, mounting, and calibration details; instructions and recommendations.
- g. Service requirements.
- h. Dimensions of instruments and details of mating flanges, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
- i. Range of each device and calibration information.
- j. Descriptions of materials of construction and listing of NEMA ratings for equipment.

B. Informational Submittals: Submit the following:

- 1. Manufacturer's Instructions:
 - a. Shipping, handling, storage, installation, and start-up instructions.
 - b. Templates for anchorage devices for materials and equipment that will be anchored to concrete or masonry.
- 2. Source Quality Control Submittals:
 - a. Results of factory testing.
- 3. Field Quality Control Submittals:
 - a. Submit the following prior to commencing system checkout and start-up.
 - 1) Completed calibration sheets for each installed instrument showing five-point calibration (zero, 25, 50, 75, 100 percent of span), signed by factory-authorized serviceman.
 - b. Field calibration reports
 - c. Field testing reports.
- 4. Supplier's Reports:
 - a. Installation inspection and check-out report.
 - b. Submit written report of results of each visit to Site by Supplier's service technician, including purpose and time of visit, tasks performed, and results obtained. Submit within two days of completion of visit to the Site.

C. Closeout Submittals: Submit the following:

- 1. Operations and Maintenance Data:
 - a. Submit in accordance with Section 01 78 23, Operation and Maintenance Data.
 - b. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.
- 2. Record Documentation:
 - a. Prepare and submit record documents in accordance with Section 01 78 39, Project Record Documents.

D. Maintenance Materials Submittals: Submit the following:

- 1. Spare Parts and Test Equipment:
 - a. General:
 - 1) Provide source quality control for spare parts as part of factory testing prior to shipment of process control system equipment.

- 2) Furnish and deliver the spare parts and test equipment as outlined below, identical to and interchangeable with similar parts furnished under this Section.
 - 3) Spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.
- b. Furnish the following test equipment:
- 1) One portable flow meter calibrator, for magnetic flow meter use only.

1.5 MATERIALS OF CONSTRUCTION FOR WETTABLE PARTS

- A. Provide compatible materials of construction for primary sensors and field instrument (wetted) parts that come in contact with the process fluids listed in the Instrument Index.

1.6 IDENTIFICATION TAGS

A. Performance Requirements:

1. Tag numbers of sensors and field instruments shall be as shown and as specified. For items not shown or specifically tagged, the item tag number shall be established by the system supplier. All instruments, whether field or panel mounted, shall have an identification tag.
2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.
3. The tags shall be fastened to the device with self-tapping stainless steel screws. Where fastening with screws cannot be accomplished the tags shall be permanently attached to the device by a circllet of stranded stainless steel wire rope and clamp.
4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel. Panel mounted devices shall have the tag attached to the rear of the device.

B. Construction Features:

1. Tags shall be engraved with 3/16-inch letters and constructed as follows.
 - a. 3/32-inch thick laminated phenolic for engraving composed of core, laminated on both sides with a matte (non-glare) finish cover sheet.
 - b. Core to be black; cover sheet to be white.
 - c. Mounting holes to be centered on width and 1/4-inch from each end.

PART 2 - PRODUCTS

2.1 MAGNETIC FLOWTUBE AND TRANSMITTER

- A. Type: Flowtube with pulsed DC Magnetic Flow Transmitter.
- B. Function: Monitor liquid flows as shown and as specified below. The transmitter shall display the monitored flow value and shall output a 4 to 20 mADC signal proportional to the monitored flow.
- C. Performance Requirements:
 - 1. Design Requirements:
 - a. Flow Rate: design flow rate, 700 gpm.
 - b. Meter Size: 6 inches.
 - c. Line Pressure: 50 psi.
 - 2. Local Indication: Lift Station Enclosure
 - 3. Accuracy (with analog output):
 - a. ± 0.5 percent of flow rate, or better, over a range from 1 fps to 31 fps.
 - b. ± 0.005 fps, or better, at flows below 1 fps.
 - c. Accuracy unaffected by changes in fluid velocity, density, pressure, temperature or conductivity (above minimum conductivity limits).
 - d. System accuracy shall be proven by submittal of flow test curves of the actual meters being furnished.
 - 1) Test curves shall show a minimum of ten equally spaced flow points. Tests shall be performed using water and a weight or volume tank. A "master meter" used as a reference standard is not acceptable. The test setup shall be submitted and approved prior to testing.
 - 4. Repeatability: ± 0.15 percent of flow rate, or ± 0.0015 fps, whichever is greater.
 - 5. Drift: Complete zero stability.
 - 6. Minimum Fluid Conductivity Limit: Five microsiemens per centimeter or less.
 - 7. Minimum Pre-amp Input Impedance: 1012 ohms.
 - 8. Power:
 - a. 120 VAC ± 10 percent, 60 Hz, ± 3 Hz power supply.
 - b. Power Consumption shall not exceed 50 watts for flowtube and transmitter combined.
 - 9. Output:
 - a. 4 to 20 mADC, direct acting and isolated, into 0 to 1000 ohms.
 - b. High accuracy, field adjustable scaled pulse output (0.1 to 10 Hz or greater) to drive local totalizer.
 - 10. Operating Temperature: Suitable for operation with process fluid temperature from 0° to 140°F.
 - 11. Pressure Rating: Greater than or equal to test pressure specified in Section 40 05 05, Exposed Piping Installation, for appropriate piping system.

D. Construction Features

1. Flowtube:
 - a. Type: Lined metal flowtubes.
 - b. Interchangeability: Ratio of flow velocity to voltage reference signals generated identical for all meter sizes to permit interchangeability with transmitter without requiring circuit modifications.
 - c. Tube Material: Type 304 stainless steel.
 - d. Electrode:
 - 1) Conical or elliptical shaped.
 - 2) Material: To be compatible with the process fluid.
 - e. Lining: To be compatible with the process fluid.
2. Enclosure:
 - a. Materials and Rating:
 - 1) Cast low-copper aluminum alloy or fabricated sheet steel.
 - 2) NEMA 6 rated.
 - 3) Capable of withstanding accidental submergence in 30 feet of water for 48 hours.
 - b. Finish: Finish exterior, except for flange faces, with a high build epoxy paint.
 - c. End Connections: ANSI Class 150 suitable for mating with pipe specified.
 - d. Electrical Connections: 3/4-inch NPT tapped holes for power conduit fitting and signal conduit fittings.
3. Pulsed DC Magnetic Flow Transmitter:
 - a. Materials and Rating:
 - 1) Die cast, low-copper aluminum alloy.
 - 2) NEMA 4 rated.
 - b. Solid state construction.
 - c. Local Indication:
 - 1) 3-1/2 digit minimum LCD meter with field selectable engineering units.
 - 2) Seven-digit electromechanical totalizer or eight digit electronic LCD totalizer with reset and lithium battery backup. Totalizer shall be integral with transmitter and visible through viewing window, or shall be externally mounted in a separate NEMA 4X enclosure or conduit with viewing window and installed adjacent to the transmitter.
 - d. Pulse and analog outputs galvanically isolated from input and earth ground.
 - e. Automatic zeroing feature making it unnecessary to zero the instrument before or after placing it in operation.
 - f. Pre-calibrated span adjustment providing continuous span adjustment over entire range.
 - g. Range Adjustment: Direct reading thumbwheel switches or calibrated potentiometer, continuously adjustable for full scale settings from 1 to 31 feet per second.
 - h. Signal Conditioning: Adjustable damping circuit with response times of 1 to 25 seconds minimum.

- i. Low Flow Cutoff: Provide automatic low flow cutoff circuitry to stop pulse output and local totalization when flow drops below 0.5 percent \pm 0.2 percent of the calibrated upper range valve.
- E. Accessories:
 - 1. Mounting:
 - a. Provide complete Type 316 stainless steel mounting hardware.
 - b. All transmitter and driver electronics shall be remotely mounted from the flow tubes at locations shown.
 - c. Type of mounting (wall, support frame or pipe stand) as required.
 - 2. Shielded cable assemblies of sufficient length for connection between flowtube and transmitter electronics.
 - 3. Type 316 stainless steel grounding rings for flowtubes.
 - 4. Type 316 stainless steel grounding straps.
 - 5. NEMA 4X rated 120 VAC power on-off selector switch.
 - 6. A spool piece for replacement of each different size flow tube where no bypass piping is provided.
 - 7. One calibrator suitable to calibrate all flow tubes provided.
- F. Products and Manufacturers: Provide one of the following:
 - 1. ABB, Magmaster.
 - 2. Endress & Hauser, Promag 53.
 - 3. Or equal.

PART 3 -

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents. Transmitters and instruments, which require access for periodic calibration or maintenance, shall be mounted so they are accessible while standing on the floor. Care shall be taken in the installation to ensure sufficient space is provided between instruments and other equipment or piping to allow for easy removal and servicing.
- B. All items shall be mounted and anchored using stainless steel hardware, unless otherwise noted.
- C. All field instruments shall be rigidly secured to walls, stands or brackets as required by the manufacturer and as shown.
- D. Conform to all applicable provisions of the NEMA standards, NEC and local, State and Federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, TESTING, AND TRAINING

- A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions, Section 40 61 23, Process Control System Startup and Field Testing, and Section 40 61 26, Process Control System Training.

+ + END OF SECTION + +

SECTION 43 21 39.13

SMART SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish and install extra heavy submersible, end suction centrifugal pumps complete and operational with fully adjustable submersible electric motors, and accessories at Lift Stations A, B, C, D, E, F, G, K, L, M, Q, R, and S. Anchorage devices are included in the scope of this Section.
- B. Coordination:
 - 1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before submersible end suction pump Work.
- C. Related Sections:
 - 1. Section 33 32 00, Packaged Sanitary Drain Lift Stations.

1.2 ALTERNATIVE PRODUCTS AND MANUFACTURERS

- A. Alternative B: Bidders must provide pricing (add or deduct) on the Bid Form for providing the Smart Submersible Pumps specified in this section, in lieu of providing the submersible pumps specified in Section 33 32 00, Packaged Sanitary Drain Lift Stations, by Base Bid Sanitary Drain Lift Station supplier, Flygt, a Xylem Corporation Brand, for the stations indicated.

1.3 REFERENCES

- A. Standards referenced in this Section are:
 - 1. ANSI/HI 1.3, Standard for Centrifugal Pumps for Design and Application.
 - 2. ANSI/HI 1.4, Standard for Centrifugal Pumps for Installation, Operation, and Maintenance.
 - 3. ANSI/HI 1.6, Centrifugal Pump Tests.
 - 4. ANSI/HI 9.1-9.5, Standard for Pumps – General Guidelines for Types, Definitions, Application, Sound Measurement, and Decontamination.
 - 5. ANSI/HI 9.6.2, Standard for Centrifugal and Vertical Pumps for Allowable Nozzle Loads.
 - 6. ANSI/HI 9.6.3, Standard for Centrifugal and Vertical Pumps for Allowable Operating Region.
 - 7. ANSI/HI 9.6.5, Centrifugal and Vertical Pumps for Condition Monitoring
 - 8. ANSI/HI 9.8, Pump Intake Design.
 - 9. ANSI/HI 11.6, Submersible Pump Tests.

10. IEEE 85, Airborne Sound Measurements- Rotating Electrical Machinery.
11. NEMA MG-1, Motors and Generators.

1.4 QUALITY ASSURANCE

A. Supplier's Qualifications:

1. Supplier shall have a minimum of five years experience producing substantially similar equipment to that required for the Project and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section, regardless of component Supplier, from one submersible end suction pump manufacturer.
2. Submersible end suction pump Supplier shall review and approve or prepare all Shop Drawings and submittals for all components provided under this Section.
3. All components shall be suitable for specified service conditions and shall be integrated into overall assembly by the submersible end suction pump Supplier.

C. Certifications

1. Certification of Compliance:

- a. Obtain certification of compliance with the Contract Documents from the submersible end suction pump manufacturer on manufacturer letterhead; certification by manufacturer's representatives is not acceptable.
- b. Certification shall be worded as follows:

"[Insert manufacturer's name] proposes to supply equipment included in Section 43 21 39.13, Smart Submersible Pumps for the Lenawee County Drain Commission, Lenawee County, Michigan, Rollin Woodstock, Sanitary Drain Lift Station Improvements. We have examined the Contract Documents and understand of the Project requirements insofar as they affect the proposed products. We certify that the products will operate satisfactorily under the conditions described in the Contract Documents and that the products meet the requirements of the Contract Documents:

[List exceptions, deviations or changes necessary or recommended to accommodate the proposed products.]

We further certify that the products to be furnished shall conform to the standards listed in Section 43 21 39.13, Smart Submersible Pumps, of the Contract Documents.

[List exceptions, deviations or changes necessary to accommodate the proposed products.]

Authorized Signature & Title

Date"

- c. Provide justification for exceptions, variations, deviations, or changes. ENGINEER will determine whether exceptions, deviations, and changes are acceptable. Exceptions, variations, deviations, and changes may result in rejection of products.
- d. Provide certification before submitting Shop Drawings. Shop Drawings will not be reviewed prior to receipt of certification.
- e. Acceptance of certification shall not relieve CONTRACTOR of responsibility for adequacy of all products.
- f. Submittal of certification shall not relieve CONTRACTOR and Supplier of requirement to comply with submittal procedures in the Contract Documents.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Shop Drawings of pump controls specified in this Section, including panel layout and wiring diagrams.
 - 2. Product Data:
 - a. Manufacturer's literature, illustrations, specifications, paint certification (if required) and engineering data including; dimensions, materials, size, weight, and part lists for all components in sufficient detail to allow an item-by-item comparison with the Contract Documents.
 - b. Pump performance data and curves showing overall pump efficiencies, required net positive suction head (NPSH), allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed, and shut-off head. Curves shall range from minimum flow to shut-off head at for full speed and all speed curves specified. For variable speed units, curves shall have at least five speeds plotted between maximum and minimum rpm. Curves shall indicate Preferred Operating Region (POR) and Allowable Operating Region (AOR), as defined in ANSI/HI 9.6.3. Specify recommended ratio of available NPSH divided by required NPSH for water service.
 - c. Motor Data: Furnish certified motor data sheet for previously tested, electrically duplicate motor to that specified, including the following:
 - 1) Speed-torque relationship.
 - 2) Efficiency at 1/2, 3/4, and full load.
 - 3) Power factor at 1/2, 3/4, and full load.
 - 4) Slip at full load.
 - 5) Running light, full load and locked rotor current.
 - 6) Temperature rises and results of dielectric tests.
 - 7) Bearing type and lubrication medium
 - 8) Insulation class and temperature ratings.
 - 3. Testing Plans, Procedures, and Testing Limitations:
 - a. Provide pump Supplier's proposed shop testing plan, including complete list of testing facility limitations.
 - b. Provide proposed field testing plan.

- B. Informational Submittals:
1. Certificates: Provide certificate of compliance as specified in this Section.
 2. Manufacturer Instructions:
 - a. Provide Supplier's instructions for handling and installing products.
 - b. Setting drawings, templates, and directions for installing anchor bolts and other anchorages.
 3. Source Quality Control Submittals:
 - a. Results of shop testing for complete pump and motor unit.
 - b. Location of nearest permanent service headquarters of pump manufacturer to the Site.
 4. Field Quality Control Submittals:
 - a. Results of field testing.
 - b. Submit a written report of the results of each visit to Site by pump manufacturer's service representative, including purpose and time of visit, tasks performed, and results obtained.
 5. Qualifications Statements:
 - a. Provide Supplier's qualifications as specified in Quality Assurance article of this specification.
- C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Manuals:
 - a. Submit complete operation and maintenance manuals, including shop and field test reports, maintenance data and schedules, description of operation, and spare parts information.
 - b. Provide operation and maintenance manuals per Section 01 78 23, Operations and Maintenance Data.
 2. Warranty Documentation:
 - a. Manufacturer's Standard Warranty.
 - b. Special Warranty, if specified.
- D. Maintenance Material Submittals: Furnish the following:
1. Follow Section 33 32 00, Packaged Sanitary Drain Lift Stations.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
1. Prior to shipping, completely inspect products to assure that components are complete and comply with all requirements. Box or crate products as required to prevent damage during shipment. Protect machined surfaces and matching connections to prevent damage.
 2. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
 3. Inspect all boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of loss or damage to products. Promptly remedy loss and damage to new condition per manufacturer's instructions.
 4. Comply with Section 01 65 00, Product Delivery Requirements.

- B. Storage and Protection:
1. Keep all products off ground using pallets, platforms, or other supports. Protect steel, packaged materials, and electronics from corrosion and deterioration.
 2. Comply with Section 01 66 00, Product Storage and Handling Requirements.

1.7 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty on Smart Submersible Pumps: Provide manufacturer's written non prorated warranty, running to the benefit of OWNER, agreeing to correct, at OWNER's option, remove, or replace materials or equipment specified in this Section and found to be defective for a period of five years after date of Substantial Completion. Replacement value of items regularly subject to wear in normal use, such as seals, bearings, impellers, rotors, and stator, may be prorated

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

- A. System Description:
1. Pumps shall be smart submersible end suction centrifugal slide rail-mounted type. Pumps shall be constructed for operation under complete submersion, partial submersion, and dry conditions. Each pump shall be suitable for its intended service.
 2. Pumps shall comply with ANSI/HI 1.3, ANSI/HI 9.6.3, and ANSI/HI 9.8.
- B. Design and Performance:

		PUMP		MOTOR
LIFT STATION	PUMP QUANTITY	FLOW (gpm)	TDH (ft)	ELECTRICAL
A	2	200	42	240v 3ph, 60Hz
B	2	320	54	240v 3ph, 60Hz
C	2	500	30	240v 3ph, 60Hz
D	2	700	18	240v 3ph, 60Hz
E	3	600	28	240v 3ph, 60Hz
F	2	215	14	240v 3ph, 60Hz
G	2	380	43	240v 3ph, 60Hz
K	2	520	31	240v 3ph, 60Hz
L	2	380	67	240v 3ph, 60Hz
M	2	200	34	240v 3ph, 60Hz
Q	2	200	45	240v 3ph, 60Hz
R	2	310	63	240v 3ph, 60Hz
S	2	370	73	240v 3ph, 60Hz

2.2 MANUFACTURERS

- A. Products and Manufacturers: Provide products of one of the following:
1. Flygt Corporation, Model Concertor NX – 6020.

2.3 DETAILS OF CONSTRUCTION

- A. Pump Materials and Construction (Extra Heavy Duty):
1. General:
 - a. Construct pumps for fluid service specified.
 - b. Construct pumps and appurtenances, including cable, for continuous submerged operation without leakage in specified depth of water.
 2. Pump Body and Externals:
 - a. Stator casing, oil casing, sliding bracket, volute, and impeller shall be close-grained, gray cast iron.
 - 1) The pump volute shall be a single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharpened groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. Due to the likely presence of sand or grit the insert ring shall be cast of Hard-Iron ASTM A-532 Alloy III A 25percent chrome cast iron and provide effective sealing between the multi-vane semi-open impeller and the volute housing.
 - b. Provide lifting eye or stainless steel lifting bail on each pump capable of bearing weight of pump during removal and installation.
 - c. Securely fasten to each pump brass or stainless steel nameplate engraved with pump manufacturer's name, pump model and serial number, pump's rated flow and head, speed, and other pertinent data.
 - d. External Hardware: Bolts, nuts, and cap screws shall have hexagonal heads and be Type 316 stainless steel.
 3. Impeller shall be semi open multi vane impeller designed to transport wastewater with fibrous materials and heavy sludge.
 - a. The impeller shall be of Hard-Iron ASTM A-532 Alloy III A 25percent chrome cast iron, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction. The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5 percent sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt.

4. Shaft: Stainless steel.
5. Seals: The shaft shall be sealed by two seals in a tandem arrangement, incorporated into a single unit assembly. The seals shall require neither maintenance nor adjustment and shall be capable of operating bi-directionally without damage or loss of seal function. The seal unit shall be designed as plug-in unit which can be replaced without any special tools. The upper seal rotating surface shall include vanes etched into the seal surface to push any potential seal leakage back towards the pump volute.
 - a. Shaft seal face material of construction:
 - 1) Pump side: - Corrosion and abrasion resistant Tungsten carbide WCCR /WCCR.
 - 2) Motor side: - Corrosion and abrasion resistant Tungsten carbide WCCR / WCCR.
6. The shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a single row ball bearing to handle radial loads. The lower bearing shall be a double row angular contact ball bearing to handle the thrust and radial forces. Single row lower bearings are not acceptable. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump performance field.

B. Motors for Extra Heavy Duty Pumps:

1. Motor shall be stainless steel solid shaft, ball bearing type. Motor casing shall be air-filled or oil-filled and watertight with moisture resistant Class H, 180 degrees C insulation. Voltage, phase, and frequency shall be as specified in "Design and Performance Criteria" in this Section.
2. Motor shall be NEMA Design B, normal starting torque, normal slip, squirrel cage induction type, continuous duty.
3. Isolate cable entry with internal terminal board.
4. Motor shall be capable of continuous operation in a non-submerged condition without damage.
5. Motor shall be non-overloading for entire pump operating curve, shall have 1.15 service factor, and provide full rated horsepower with a voltage unbalance of three percent. Motors for use with variable frequency drives shall have insulation system constructed in compliance with or exceeding NEMA MG-1 Part 31.
6. Motor cable shall be suitable for submersible duty and be so indicated by code or legend permanently applied to cable.
7. Motor thrust bearings shall be capable of continuous thrust loads under all conditions of pump operation from zero head to shut-off. Anti-friction bearings shall be rated for B-10 life of 100,000 hours.
8. The pump shall be operated by a synchronous motor with an integrated control system and be capable to run at constant power at any point of the performance field without being overloaded. Motor shall utilize a permanent magnet rotor to maintain synchronous speed and maintain level IE-4 premium efficiency standards. The motor shall withstand at least 60 starts per hour.

C. Integrated Pump Control System:

1. Provide an integrated pump control system installed in the pump/motor housing to ramp up the speed at start-up of the pump to reduce the start-up current and secure that the direction of the impeller rotation is always correct. There shall be no need for any human intervention to ensure that the impeller is rotating in the correct direction within the volute. The integrated control system shall be encapsulated to protect it against moisture ingress, and vibration. Motor, pump and control system shall be designed and produced by the same manufacturer.
2. The integral control system shall be capable of adjusting the motor/impeller speed so that the pump can safely operate without overloading anywhere within the pumps' operating envelope.
3. The pump control system shall incorporate a "pump-cleaning" function to remove debris from the impeller. The cleaning function shall be initiated when the integral control system senses an increase in current draw due to debris in the pump. The cleaning function shall consist of forced stopping, reversal and forward runs timed to allow for debris to fall from the impeller. After cleaning cycle is complete, the pump shall resume automatic operation. If the pump impeller/volute does not clear itself after the programmed number of attempts, the control system shall initiate an alarm to indicate the pump inlet/volute is blocked by large debris.
4. Motor Sensors:
 - a. The integrated control system shall continuously monitor the leakage sensor in the stator housing and the temperature of the motor.
 - 1) If the motor temperature is elevated beyond the normal range, the pump shall be capable of operating at a reduced speed until the high temperature conditions are normalized.
 - 2) The operator shall be able to modify the setting of the control system to decide if the active leakage signal shall stop or not stop the pump.
 - 3) External trips or overload devices for motor protection shall not be required.

D. Gateways:

1. Provide one gateway per pump which shall offer at least the following interfaces:
 - a. 1 USB.
 - b. 1 RS485.
 - c. 1 Ethernet RJ 45.
 - d. 1 display interface.
 - e. 4 digital outputs.
 - f. 4 digital inputs.
 - g. 1 Analog input & output.
 - h. 2 wire connections for pump communication.
2. Gateway housing shall be isolated according to protection class IP 20 and able to operate in ambient temperature of -20 °C to +60°C.
3. The supply power to the gateway shall be 24 V DC.
4. The pump gateway shall allow controlling the pump through I/O, Modbus RTU or TCP.

5. The gateways shall have high level float input to run the pump if the main controller fails.
6. The gateway shall have LED light to indicate pump alarms and the unit shall communicate these alarms to the hosted SCADA service.
7. The gateways have the UL mark and be designed and manufactured by the pump manufacturer.

E. Pump Accessories:

1. Provide the following for each pump unless otherwise specified.
 - a. Anchor bolts and anchorage devices per Section 05 05 33, Anchor Systems.
 - b. Discharge Elbow: Comply with requirements of Section 40 05 19, Ductile Iron Process Pipe.
 - c. Pump Removal System:
 - 1) Pumps shall automatically and positively mate and self seal with associated discharge piping when pump is lowered into place. Pumps shall be removable for inspection or service without requiring removal of bolts, nuts, or other fastenings.
 - 2) Provide for each pump guide rails and brackets of extra-heavy Type 304 stainless steel.
 - 3) Provide each pump with high-tensile strength, proof-tested stainless steel lifting cable. Cable shall be suitable for use with hoist. Provide sufficient length of cable for removing pump from wet well without requiring supplementary cords, cables, or chains. Connect cable to lifting eye or bail on pump, and provide loop or appropriate hardware at hoist-end of cable. Cable and hardware shall be sized to sustain all tensile stresses during lifting of pump.
 - 4) For each pump, provide one suitable stainless steel hook or bracket on wall just below operating floor to which cable will be hooked when not used for hoisting.
 - 5) Pump manufacturer shall provide items necessary for complete guide-in, pump removal system.

F. Products and Manufacturers:

1. Flygt Corporation, Model FPG 412 (DP).

2.4 CONTROLS

- A. Follow paragraph 2.1.L in Section 33 32 00 Packaged Sanitary Drain Lift Station.

2.5 FINISHING

A. Shop Finishing:

1. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be blasted and surface oils and debris removed for proper coating adhesion before coating. All wet surfaces are to be coated with two-pack oxyrane ester Duasolid 50. The total layer thickness should be at least 120 microns. Zink dust primer shall not be used.

2. At the factory, pumps, motors, and appurtenances shall receive manufacturer's standard finish paint system suitable for service conditions specified in this Section.
- B. Field painting shall conform to Section 09 91 00, Painting. Touch-up of factory-applied finishes shall be compatible with factory-applied finish and specified service conditions.

2.6 SOURCE QUALITY CONTROL

- A. Pump Shop Tests: Shop Test all pumps provided under this Section.
 1. Performance Test: Operate each pump assembly from zero to maximum capacity as shown on pump curve in approved Shop Drawing. Present results of test in plot of test curves showing head, flow, horsepower, efficiency, and current. Obtain data at minimum of five evenly spaced capacity points along curve including shut-off, design points, and minimum head for which pump is designed to operate. Conduct tests per ANSI/HI 1.6 and ANSI/HI 11.6.
- B. Motor Tests and Data:
 1. For each motor, provide an inspection report for job motor or a previously tested electrically duplicate motor. Provide the following minimum data:
 - a. Running light current.
 - b. Locked rotor current.
 - c. Winding resistance measurement.
 - d. High potential test.
- C. Lift Station System Testing: Station electrical and control system and the pumps shall be tested as a complete assembly by the pump manufacturer at the place of assembly prior to shipment. The test shall include operational performance of all components as an integrated system and demonstration of correct operation of all system functions under actual hydraulic conditions, including liquid level changes, soft start/stop pump operation as a function of liquid level, automatic and manual control of pumps under load, and other automatic control and data collection requirements specified including output to contacts for local and remote alarms. OWNER, ENGINEER, and CONTRACTOR shall be notified at least 10 days in advance of testing and given the opportunity to witness the system testing at the pump manufacturer's facilities.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine conditions under which products are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

- A. Install products in conformance with manufacturer's instructions and recommendations, and the Contract Documents.
- B. Anchorages:
 - 1. Install pumps on concrete bases. Provide anchorages in new or existing concrete, as applicable, per equipment manufacturer's recommendations and the Contract Documents. Equipment manufacturer shall supply templates to facilitate location of anchorages for equipment. CONTRACTOR shall coordinate with Supplier to assure timely receipt of required templates.
 - 2. For pumps installed in dry pit applications, install grout between pump and concrete base per recommendations of pump manufacturer.
- C. General:
 - 1. Conform to ANSI/HI 1.4.
 - 2. Perform all fitting required for installation. Set products accurately in location, alignment, and elevation, plumb and true.
 - 3. Provide utility connections per the Contract Documents. Support piping and valves independent of pump. Verify that utilities and valves are tested and operational before placing equipment into operation. When pumps are connected to piping with rigid hardware, connection of discharge nozzle to piping shall conform to ANSI/HI 9.6.2.
 - 4. Align and adjust products and piping in presence of ENGINEER
 - 5. Provide for initial operation lubricants recommended by equipment manufacturer
 - 6. Prior to energizing motor driven equipment, rotate drive motor by an external source to demonstrate free operation of mechanical parts. Do not energize equipment until safety devices are installed, connected, and functional.
- D. Conform to Section 01 75 11, Checkout and Startup Procedures.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Services: Provide qualified, factory-trained serviceman to perform the following:
 - 1. Instruct CONTRACTOR on installing equipment.
 - 2. Inspect and adjust equipment after installation to ensure proper operation.
 - 3. Test-operate the products in presence of ENGINEER and verify that equipment conforms to Contract Documents.
 - 4. Instruct OWNER's personnel on operating and maintaining the products.
 - 5. Manufacturer's representative shall make a minimum of two visits to each lift station on the project, with a minimum of two hours onsite for each visit. First visit shall be for assistance in installing equipment ; second visit shall be for checking completed installation and start-up of system. Representative shall revisit the Site as often as necessary until installation is acceptable.

6. Training: Furnish services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of products. Training requirements, duration of instruction, and other qualifications shall be per Section 01 79 23, Instruction of Operations and Maintenance Personnel.
7. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to Site shall be included in the Contract Price.

B. Site Tests:

1. Following installation, CONTRACTOR and qualified field service representative of equipment manufacturer shall conduct operating tests of all equipment, functions, and controls at Site, in presence of ENGINEER. Should tests result in malfunction, make necessary repairs, revisions, and adjustments and restart test from beginning. Repeat tests and repairs, revisions, and adjustments until, in opinion of ENGINEER, installation is complete and equipment is functioning properly and accurately, and is ready for permanent operation.
2. Field Operating Test:
 - a. When station is complete and ready for operation as intended CONTRACTOR shall supply water in volume adequate to operate station through several pumping cycles.
 - b. Field test equipment and its controls in local mode, followed by demonstrating proper operation and controls in automatic mode. Demonstrate that each part and component of system individually and all parts and components together function properly in manner intended.
 - 1) Observe and record operation of pumps, suction and discharge gauge readings, ampere draw, pump controls, and liquid level controls.
 - 2) Verify proper transfer and operation of generator at stations were relocated.
 - 3) Check calibration of all instrumentation equipment.
 - 4) All testing equipment and manpower shall be by CONTRACTOR.
 - c. Conform to applicable provisions of ANSI/HI 9.6.5.

C. 30-Day Operating Period:

1. Following completion of the Field Operating Test, when, in the opinion of the ENGINEER, the installation is ready for permanent operation, flow from the influent sewer can be restored to the wet well, beginning the 30-day period of
2. operation required per Supplementary Condition 15.03.B.

+ + END OF SECTION + +

SECTION 43 23 13.19

TRAILER-MOUNTED CENTRIFUGAL PUMP

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish a trailer-mounted centrifugal trash pump complete and operational with priming assist system, diesel engine drive, control equipment and accessories as shown and specified.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. ANSI/ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pump manufacturer.
2. The pump equipment manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pump equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:

- a. Manufacturer's literature, illustrations, specifications and engineering data including: dimensions, materials, size, weight, performance data and curves showing overall pump efficiencies, required net positive suction head, allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed and shut-off head.

2. Shop Drawings:
 - a. Fabrication, assembly, installation and wiring diagrams.
- B. Informational Submittals: Submit the following:
 1. Source Quality Control:
 - a. Pump test report.
- C. Closeout Submittals: Submit the following:
 1. Operation and Maintenance Data:
 - a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
 - b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.
 2. Field Quality Control Submittals:
 - a. Results of field testing.
 3. Warranty Documentation:
 - a. Manufacturer's Standard Warranty.
 - b. Special Warranty, if specified.
- D. Maintenance Material Submittals: Furnish the following:
 1. Spare Parts:
 - a. One mechanical seal set for pump.
 - b. One set of gaskets.
 - c. One shaft sleeve.
 - d. One spare tire for trailer.
 - e. All other items as listed on the manufacturer's list of recommended spare parts.
 2. Tools: Two sets of special tools required for normal maintenance or operation.
 3. A durable maintenance schedule, laminated in clear plastic, for the pump, drive and trailer shall be furnished by the manufacturer.

1.5 WARRANTY

- A. General Warranty: The special warranty specified in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.
- B. Special Warranty on Trailer Mounted Centrifugal Pump:
 1. Provide manufacturer's written non prorated warranty, running to the benefit of OWNER, agreeing to correct, at OWNER's option, remove, or replace materials or equipment specified in this Section and found to be defective for a period of one year after date of Substantial Completion.

2. As part of the manufacturer's standard warranty or in addition to the manufacturer's standard warranty, provide the following at minimum:
 - a. Full coverage of engine parts and labor for one year from the date the equipment is placed in operation. This service shall include the cost of all replacement parts required during this interval.
 - b. Full coverage of pump parts and labor for one year from the date the equipment is placed in operation. This service shall include the cost of all replacement parts, including mechanical seals, required during this interval.

PART 2 - PRODUCTS

2.1 EQUIPMENT DESIGN

- A. General: Pump shall be diesel engine driven, priming-assisted, centrifugal trash type with an integrated trailer-mount and sound attenuation unit. Equipment shall be specially designed, constructed, and installed for the service intended.
- B. Design Criteria:
 1. Quantity: One.
 2. Location: Portable.
 3. Service: Sanitary or storm sewer flows.
 4. Maximum sphere diameter to be passed: 3-inch.
 5. Capacity: 850 gpm, maximum.
 6. Suction lift: 25 feet (maximum) at sea level.
 7. Discharge Head: 54 feet, maximum.
 8. Noise at 30 feet: 68 dBA, maximum.

2.2 MANUFACTURERS

- A. Provide products of one of the following:
 1. Godwin Pumps, a Xylem Brand.
 2. Gorman-Rupp Pumps.
 3. Global Pump, a Mersino Company.
 4. Or equal.

2.3 DETAILS OF CONSTRUCTION

- A. Pump Materials and Construction: The pump shall be a centrifugal trash pump, with close-coupled drive, and conform to the following:
 1. Casing: The casing shall be cast-iron, designed to retain sufficient liquid for re-priming, and be constructed so that the suction flow path is in axial alignment with the impeller eye.
 2. Impeller: The pump impeller shall be of semi-open, non-clog type with pump out vanes on the back shroud. The impeller shall be a 2-vane design and manufactured of ductile iron 65-45-12, or equal.

3. Wear Plates: Wear plates shall be cast iron, and fully adjustable and replaceable. Wear plate clearances shall have no relationship to the ability of the pump to achieve a prime.
4. Bearings and Shafts:
 - a. The pump shall be fitted with a bearing bracket containing the shaft and heavy duty ball or tapered roller bearings of adequate size to withstand imposed loads. Bearings shall have with a minimum L-10 life of 100,000 hours.
 - b. Impeller shaft shall be constructed of stainless steel 17-4 PH or 1-1/2 percent nickel/chromium steel.
5. Seals:
 - a. Seals shall be high pressure, mechanical, self-adjusting type with silicon carbide faces capable of withstanding suction pressures up to 100 psig.
 - b. Mechanical seals shall be cooled and lubricated in an oil bath reservoir requiring no maintenance or adjustment. The pump shall be capable of running dry with no damage for periods up to 24 hours.
 - c. All metal parts shall be stainless steel.
 - d. Elastomers shall be Viton.
 - e. The rotating part of the seal shall be located behind the wear plate in the oil bath reservoir, allowing the pump to run dry indefinitely.
6. Pump gaskets shall be compressed fiber or Teflon.
7. Pump o-rings shall be Viton.
8. Pump suction and discharge connections shall be cast iron, raised face class 125 flanges in accordance with ANSI/ASME B16.1.
9. The pump shall be furnished with an integral check valve mounted on the discharge flange of the pump, allowing unrestricted flow out of the impeller. The check valve shall prevent inline return of flow when the pump is shut off. Non-return valve elastomers shall be high nitrile rubber and shall be field replaceable.
10. All bolts, nuts and cap screws shall have hexagon heads.
11. Brass or stainless steel nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.

B. Priming Assist System:

1. The pump shall be fitted with a fully automatic priming system incorporating an air compressor, air ejector assembly, and an air/water separation tank. Water shall not be required in the pump to achieve a prime. The air ejector shall operate on the discharge side of the compressor, eliminating the possibility of water being drawn into the air source. The pump shall be capable of running totally dry for periods up to 24 hours. The pump shall be designed for an automatic dry priming system and not just an add-on to a recirculating wet priming pump end.
2. The priming system shall not use a vacuum or diaphragm pump, nor require the use of a foot-type valve. A field demonstration of the pump's ability to repeatedly cycle from pump/snore/reprime/pump is required prior to acceptance of the equipment.
3. The priming system shall be fully automatic, needing no form of adjustment.

C. Drive Engine:

1. Pump shall be driven by diesel engine. Engine shall drive pump by use of direct connect intermediate drive plates.
2. Starter shall be 12-volt electric.
3. Provide safety shutdown switches for low oil pressure and high temperature.
4. Battery shall have 180-amp hour rating.
5. Pump shall include a tachometer and an hour meter.
6. Provide mechanical-type governor. Engine speed shall be adjustable to operate pump between maximum and minimum design operational speeds.
7. Provide throttle control for manual variable speed operation.
8. Pump shall include a control panel with submersible transducer liquid level sensor for automatic flow-pacing with pump/engine.
Provide integral trailer fuel tank with a minimum capacity of 60 gallons. The engine shall be capable of operating satisfactorily on a commercial grade of diesel fuel.

D. Trailer: Pump manufacturer shall install pump and drive engine as an integrated, self-contained package on a trailer equipped with sound attenuating enclosure. Equipment shall be solidly mounted on the trailer chassis. It shall withstand all stresses and strains due to off the road transportation and operation. The trailer mount shall offer a stable platform for equipment operation hitched or unhitched from its tractor. Pump, engine and trailer shall be factory assembled and aligned for smooth operation, free of excessive vibration and noise.

1. The pump and drive engine shall be trailer-mounted within a sound-attenuating enclosure on a tandem-axle trailer with vehicular pneumatic tires that can be towed on roadways at 50 miles per hour (mph) and shall be wired for over-the-road usage per DOT standards. Trailer shall include electric brakes with safety breakaway and pintel-type trailer hitch.
2. Tires and torsion bar suspension shall be adequately sized for the required load range ratings.
3. Trailer shall be furnished with fenders, heavy-duty front jack with sand shoe, two rear stabilizer jacks, lifting bar, safety chains, side and rear reflectors, standard DOT LED lights, and seven-way light cord.
4. Total trailer length shall not exceed 180 inches.
5. Trailer shall comply with applicable DOT regulations.

E. Accessories:

1. Discharge flanged elbow.
2. Suction companion flange.
3. Pressure gage.
4. Mechanical fuel gauge.
5. Provide pumps with 6-inch diameter female quick connect couplings at suction and discharge in accordance with Section 40 05 08, Valves and Miscellaneous Piping Appurtenances.

6. Supply 30 feet of 6-inch diameter suction hose in ten-foot lengths with quick connect couplings, in accordance with Section 40 05 08, Valves and Miscellaneous Piping Appurtenances, male at one end female at the other. Hose shall be neoprene lined with a heavy-duty cover of nylon. Hose shall be reinforced to prevent suction collapse.
7. Supply four 10 foot lengths of 6 inch discharge hose (i.e., 40 feet total) with quick connect couplings, in accordance with Section 40 05 08, Valves and Miscellaneous Piping Appurtenances, male at one end female at the other. Material shall be heavy-duty, neoprene lined and nylon covered.
8. Supply three quick connect 6-inch by 4-inch reducer adapter/couplers for connecting female end of 6-inch diameter hose to 4-inch diameter male adapters at packaged pumping stations. Materials for reducer adapter couplings shall be as indicated for quick connect couplings in Section 40 05 08, Valves and Miscellaneous Piping Appurtenances.

2.4 SHOP FINISHING

- A. Pump, engine, frame, trailer, sound enclosure and all ferrous metal surfaces, and appurtenances shall receive manufacturer's standard shop primer and shop finish coating.
- B. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating.

2.5 SOURCE QUALITY CONTROL

- A. Shop Tests:
 1. Pump casings shall be hydrostatically tested to twice the discharge head or 1-1/2 times the shutoff head, whichever is greater.
 2. Pump Priming Test: Pump shall be prime tested in accordance with the manufacturer's standard testing procedures.
 3. Running Test: Pump assembly shall be operated from zero to maximum capacity, as shown on the approved pump curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency and NPSH. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point, and minimum head for which pump is designed to operate.
 4. Pumps shall not be shipped until the ENGINEER has approved the test reports.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Services:

1. A factory trained representative shall be provided for start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of one visit, minimum eight hours on-Site, to the Site. Visits shall be for start-up of the system and training of OWNER personnel. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
2. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the OWNER.

B. Field Tests:

1. Manufacturer's representative shall check and approve the trailer mounted pump package prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the OWNER's satisfaction.
2. All equipment will be given running tests by manufacturer's representative at the job Site following delivery. Should the tests indicate any malfunction, manufacturer's representative shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the equipment is functioning properly and accurately.

+ + END OF SECTION + +

